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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to ensure publication in that week's issue.

Attention is called to a communication which appears on another page of this issue on the question of preventing electrolytic corrosion of water and gas mains. Mr. Hanchett makes an able defence of the insulated joint as a preventative for this destructive action, and as the subject is timely and worthy of full discussion his letter will undoubtedly be widely read with interest in electrical and related fields.

THOROUGH TEST OF THE COST OF ELECTRICAL OPERATION.

The Institute paper by Mr. Bion J. Arnold, describing the use of the dynamometer car, of which an abstract appears on other pages of this issue, gives a fair idea of the elaborate means which are now so frequently employed for solving engineering problems.

In this case the problem presented was a study of the conditions governing the operation of trains of the New York Central Railroad between Mott Haven Junction and the Grand Central Station, and involved a choice of system. Over this division there are nearly six hundred train movements a day.

The first question presented was to determine the cost of operating the road by electricity. Not until this had been done could intelligent comparison be made with steam. The mode of attack was as follows: A dynamometer car, owned jointly by the University of Illinois and the Illinois Central Railway, was secured with a corps of competent assistants. This car was coupled to various trains operated over the different divisions of the road and a number of runs made in each direction. In this way continuous records showing the tractive effort, speed, etc., were obtained under all conditions. The curves thus obtained were integrated and the average power used by each train determined and the values, after allowance has been made for the efficiency of the motor, reduced to kilowatts input. Then, knowing the number and kind of trains in operation during all hours of the day, a load diagram was constructed showing the calculated output of the station for the whole day. Additional complications were brought in by the need of providing for secondary movements of trains, such as switching, etc., the whole subject requiring a great deal of time and a broad perspective. After the load diagram had been constructed the engineer had sufficient data to design a suitable station and to estimate its first cost and operating expenses. This done, an intelligent comparison can be made with steam, and a choice of systems based upon known conditions can be made.

The point we would like to emphasize here is the soundness of this method of procedure. Nothing is left to guesswork, but all is determined by actual measurement. No factor of safety is needed to ensure successful operation. A corps of experts is employed. One trial run with each train is not deemed sufficient, so several are made. The enormous mass of data obtained in this way is then reduced into useful figures. This work alone must have taken months to complete. These averages being obtained, and with a train schedule at hand, the engineer constructs his daily load diagram, not by guesswork, but as he knows it will be. There is no uncertainty about it. Each and every stone in the structure has been measured and put in its proper place. No assumptions are made, as even the simplest detail has been considered. No theorizing is allowed, and the final report is based upon these facts. Naturally, in the final decision other factors must be considered—flexibility, smoke nuisance, etc.—but these questions are not involved in the determination of the actual cost and operating expenses of the station. Could there be a surer basis for a report? Has any of the other learned professions a safer method of procedure? In other professions reports are usually based upon opinions. Questions of engineering are decided by facts. Science itself could not proceed in a more exact and scientific manner.

NEW THEORIES.

Somebody or other some time ago suggested that an atomic theory of electricity might be adopted. His argument was based upon the then accepted idea that electricity was a form of energy, and it

was only necessary that certain conditions be realized for it to appear.

According to the atomic theory the smallest particle of matter was an atom, and this atom required a definite amount of energy to be associated with it in order to exist as that atom under any given conditions. During electrolytic action these atoms passed into solution as ions, and a definite portion of the potential energy of the atom appeared as electric energy and was available. All univalent atoms had associated with them a fixed charge; all bivalent atoms had also a fixed charge, double that of the univalent, and so on. Therefore, the smallest quantity of electricity which could be conceived of as existing alone was the charge of the univalent atom. The suggestion was that this quantity be adopted as the atom of electricity.

The atomic theory to-day is threatened with disaster. Matter seems to exist in a finer state of division than our old friend, the atom. Particles of the latter—electrons, they are called—are torn off and shot into space. These particles appear as negative charges, while the remnant of the atom is positively charged. We have worked back to the old material theory of electricity, and if electricity is matter, why not all other forms of energy?

Light and electricity have been coordinated. Is matter to meet with the same fate? Are we to have one fundamental atomic theory for the sciences? Or is there to be but one science?

RECENT STUDIES IN MAGNETIC MATERIALS.

There has been of late a revival of interest in the study of the properties of magnetic materials. It will be remembered that early this year a paper was read by Messrs. Barrett, Brown and Hadfield before the British Institution of Electrical Engineers, in which were given the results of an extended investigation of the magnetic and electric properties of iron alloys. Some of these results were exceptionally interesting, not only scientifically, but as pointing to a possible improvement in the construction of electromagnetic apparatus.

In this issue there appears the first section of an article by Professor Ernest Wilson, of King's College, London, on "The Dissipation of Energy by Electric Currents Induced in an Iron Cylinder when Rotated in a Magnetic Field." This is the second paper to be presented by Mr. Wilson to the Royal Society on this general subject, the first having been an investigation of the magnetic reaction of Foucault or "eddy" currents. He here describes the method used in the experimental research, compares the results thus obtained with those computed theoretically, and concludes with a mathematical discussion of the theory of Mr. J. B. Dale.

The experimental work was performed by placing exploring coils within openings drilled in various portions of the iron cylinder, and by means of these coils the electro-motive-force waves for the various ringlike sections of the cylinder were determined. From these waves the effective values acting along each path are deduced. The resistance of each path was calculated, and the energy loss determined in the usual way. As, of course, the loss thus determined is that for one ring only, to find the total loss in the cylinder these values are integrated in both the horizontal and vertical planes.

The results found by Professor Wilson in this way are less than those computed from theoretical considerations, this difference being attributed to the variations in the density of magnetic induction. Comparison is then made of the results of this work, and the loss as given by the formula agreed in by Fleming, Steinmetz and Thompson for an alternating field, and it is found that the loss due to the rotating field is much the greater.

The importance of this research into the properties of our materials of construction will readily be recognized. It is to be hoped that further work will be carried out along this and allied lines, for there is little doubt that it would result in securing much valuable information. While our present electrical apparatus is probably the most efficient machinery ever constructed, the possibility of even a slight improvement in this respect is not to be lightly estimated. There is, however, more to be gained by reducing the weight and simplifying the construction of our machine than by a slight increase in efficiency. The output of dynamos and motors to-day is limited by the heat which can be radiated from the active surfaces, while the weight is determined by the maximum permissible flux density. The possibility of improvement in both of these respects would mean a smaller, lighter and—should no laminations be found necessary—a much simpler and cheaper machine. We are looking forward to the possible improvement in other branches of electrical engineering, notably in accumulators and lamps. If we can at the same time bring about considerable reduction in the size, weight and cost of dynamos and motors, the effect upon electrical development will be far-reaching.

CIVIL SERVICE EXAMINATIONS.

While it is always easy to criticise matters in which one has had but slight experience, there are circumstances in which this may be tolerated. It would seem that there is some room for improvement in the present method of conducting civil service examinations. At the recent examination for laboratory assistant for the National Bureau of Standards, the candidates were examined in three subjects in which some option was given, and for which six and one-half hours were allowed. The questions were all fair and, though possibly somewhat elementary, were such as to give a good idea of the candidates' training. The time required, however, seems excessive. From twenty minutes to a half hour is taken in filling preliminary blanks and getting started, then six and one-half hours are given to the examination proper, with an additional ten to fifteen minutes in filling out a supplementary statement, making in all, say, seven hours' work if the candidate uses the full time. This seems to be rather long and not conducive to the best results. The candidate is not expected to leave the room, and, indeed, if there are many taking the examination this should not be allowed; but can any one write steadily for this length of time without rest or relief of any kind and do himself justice? If it is necessary to set such long papers, why can they not be set in two sessions with short intermission? The examination is supposed to be a test of intelligence and training, and not of endurance.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—XLVII.

BY W. ELWELL GOLDSBOROUGH.

Having determined the characteristics of any one of the three phases of the generator under single-phase working, we can determine the performance of each of

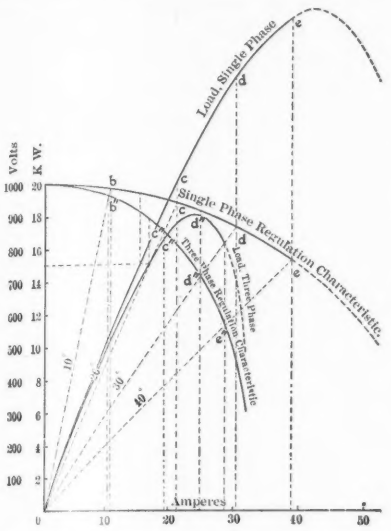


FIG. 170.—ALTERNATING DYNAMO ELECTRIC MECHANISMS.

these phases when all three of them are gradually equally and non-inductively loaded down. To do this, we have first to measure off the values of the projections of the field inductance flux vectors upon the flux vector OM_0 for the several degrees of loading of the first phase under single-phase conditions (as shown in Fig. 168). The values of these projections, namely, $M_0M^b_p = 2 \times 10_4$; $M_0M^c_p = 7.2 \times 10^4$; $M_0M^d_p = 14.8 \times 10^4$; and $M_0M^e_p = 25 \times 10^4$ have been successively multipled by two and plotted in the column headed Φ_p of table 22. The sum of these projections has been added to the value of $OM_0 = 140 \times 10^4$, and tabulated in the column headed Φ_q of table 22. Now, the ratios of Φ_0 to Φ_q for the several degrees of loading, give the constants by which the values of E and I must be reduced in order to obtain the values of E″ and I″, which latter are the electro-motive force and current values developed in each of the three phases when these phases are symmetrically and non-inductively loaded, so that the currents in them will lag 10, 20, 30 and 40 degrees respectively behind their total internal electro-motive forces. The product of the values given in the columns of table 22, headed E″ and I″, gives the total power developed in each of the phases of the generator under three-phase working. They are tabulated in the column headed P_0''. When E″, I″ and P_0'' are plotted in rectangular co-ordinates, they give the three-phase regulation and load curves of Fig. 170, and when E″ and I″ are plotted in polar co-ordinates, they give the three-phase regulation curve of Fig. 169.

The curves of Fig. 170 are particularly interesting, inasmuch as they throw into marked contrast the behavior of a three-phase machine under single and three-phase working. The maximum power developed by any one phase under single-phase working and non-inductive loading is 30.4 kilowatts. The same phase, when all three phases are equally loaded non-inductively, will only develop a maximum of eighteen kilowatts, or a little over one-half of the power. Since the generator is a forty-five-kilowatt machine, each phase under normal conditions should generate fifteen kilowatts. Under single-phase conditions, any one of the phases will develop its quota of the power with a drop of three per cent in voltage below the no-load voltage. When, however, the generator is fully loaded and each phase is developing fifteen kilowatts under non-inductive load, the drop is as much as eleven per cent below the no-load electro-motive force.

In Fig. 170, as in Fig. 167, the small letters *b*, *b″*; *c*, *c″*; *d*, *d″* and *e*, *e″* represent common points on the regulation and output characteristics for equal degrees of lag of the currents behind the total internal electro-motive forces under both single-phase and multiphase conditions of loading.

In the foregoing discussion of the relative performance of two and three-phase generators, the assumption has been made that the armature circuits of both machines have the same armature inductance, and that this armature inductance is divided in the same proportion between the field inductance and the local inductance. We are, therefore, able to compare the performances of these machines somewhat more in detail than would be possible under other conditions. Accordingly, in Fig. 171 the regulation curve for single-phase working represents the performance of both the two and three-phase generators when only one phase of each is loaded. The two-phase regulation curve shows the performance of the two-phase generator when both phases are equally and non-inductively loaded, and the three-phase regulation curve the performance of the three-phase generator when each of its phases is equally and non-inductively loaded. The same comparative values pertain to the load curves. The load curve, single-phase working, shows the performance of both of the generators under single-phase conditions. The total load curve, two-phase working, shows the performance of the two-phase generator when both of its phases are equally and non-inductively loaded, and

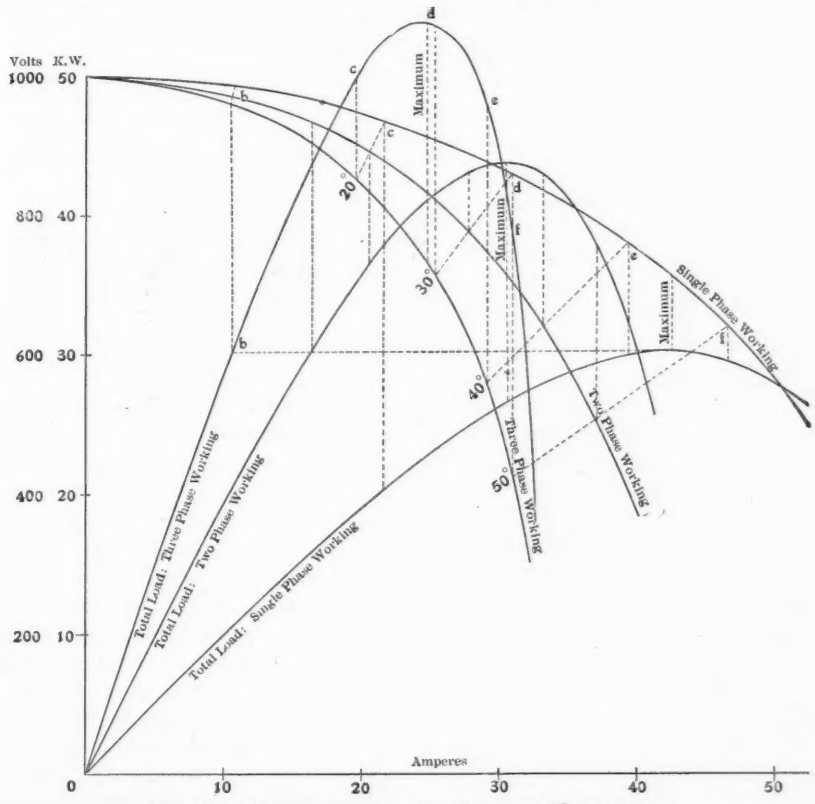


FIG. 171.—ALTERNATING DYNAMO ELECTRIC MECHANISMS.

the total load curve for three-phase working shows the performance of the three-phase generator when its phases are equally and non-inductively loaded. The load curves in Fig. 171 show the total output of the machines under the conditions specified, instead of merely the output of one of the phases.

We find, therefore, that the total output of the three machines occurs earlier than does the total output of the two-phase machine, and we further find that the regulation of the three-phase machine is slightly better than the regulation of the two-phase machine at the point of maximum output. Similarly, when either of the machines is working under single-phase conditions, the maximum power which can then be developed is delivered at a lower voltage than is the maximum power under either two or three-phase working.

We, moreover, see that the maximum power which any one phase of either of the machines will develop under single-phase working is thirty kilowatts, and that this power is not delivered until the voltage has fallen off forty per cent below its no-load value. Under two-phase conditions, this load is developed with only a seven per cent drop in voltage, and under three-phase working, 30 kilowatts are developed with a four per cent drop. For equal degrees of output, therefore, an increase in the number of phases improves the regulation of a generator where the armature inductance constants are the same.

The data from which the curves shown in Fig. 171 have been plotted are taken from tables 21 and 22, and collected in table 23.

TABLE 23.

Data pertaining to Fig. 171.

	E Volts. 1 Phase.	E′ Volts. 2 Phase.	E″ Volts. 3 Phase.	P_0 Kw. 1 Phase.	$2\ P_0'$ Kw. 2 Phase.	$3\ P_0''$ Kw. 3 Phase.
a	1000	1000	1000	0	0	0
b	985	971	958	10.85	21.00	30.75
c	938	892	850	20.20	36.40	49.71
d	863	780	712	26.40	43.00	53.76
e	762	647	561	29.85	43.00	48.63
f	640	511	425	29.70	37.80	39.30
g	500	378	304	26.20	30.08	29.16

A great many good commercial storage batteries are ruined because of improvident charging. Lack of charging, if continued long enough, will result in sulphate forming on the plates which is indicated by white patches. In this condition the cells should be charged at half rate until the sulphate entirely disappears. Pure water should be added to make up loss by evaporation, care being taken, however, that the specific gravity of the solution is not lowered to any considerable extent.

METHOD OF ASCERTAINING BY MEANS OF A DYNAMOMETER CAR THE POWER REQUIRED TO OPERATE THE TRAINS OF THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD BETWEEN MOTT HAVEN JUNCTION AND GRAND CENTRAL STATION, AND THE RELATIVE COST OF OPERATION BY STEAM AND ELECTRICITY.*

BY BION J. ARNOLD.

In August, 1901, the writer was commissioned by the New York Central Railroad Company to study the conditions governing the operation of its trains between Mott Haven Junction and Grand Central Station, and to report upon the feasibility of operating them by electricity. This division consists of 5.3 miles of four-track road forming the trunk line or main artery over which the trains from the three divisions of the New York Central and the main line of the New York, New Haven & Hartford railroads enter the city of New York. For 2.58 miles from Mott Haven Junction the tracks are carried on an elevated stone and steel structure; then for 2.04 miles through a tunnel underneath the street, emerging into an open cut 0.68 of a mile long, then terminating at the Grand Central Station in an intricate stub-end yard, having about eight miles of switching tracks. Over this division are made nearly 600 train movements per day, as almost all trains entering the yard or station must be returned to Mott Haven Junction, owing to lack of sufficient storage tracks at the Grand Central terminus.

The annoyance to passengers due to the use of steam locomotives in the tunnel, caused the company to examine into the advisability of adopting electricity, and it is through the courtesy of Mr. W. J. Wilgus, chief engineer of the company, under whose directions the investigation was made, that the writer is allowed to present to this Institute the technical substance of this report.

All money values relating to total cost of installation, real estate, etc., and many other elements upon which the final recommendations of the report were based, together with many of the general recommendations and conclusions themselves, are necessarily omitted from this paper, but it is believed that the data given are sufficiently complete to enable one to check the technical conclusions herein given.

Soon after taking up the work it became evident, on account of the number and weights of the trains to be handled and the numerous variable elements entering into the operating system, which would not adapt themselves conveniently to formulæ, that the most practical and satisfactory way of ascertaining the power required to propel the trains was to measure, by means of a dynamometer car, the "draw-bar pull" of a sufficient number of trains of various weights to determine the average power required per train and from this compute the general load diagram.

A dynamometer car known as "Test Car No. 17," owned jointly by the Illinois Central Railway Company and the University of Illinois, was secured, and men thoroughly skilled in its use were employed to operate it. This car was coupled between the engine and the train in each case, and operated on trains running over the different divisions of the road, so that not less than four runs, two or more in each direction, were made for each class of train. Since the trains of all divisions, including those of the New York, New Haven & Hartford Railroad, run over the New York Central tracks between Mott Haven Junction and Grand Central Station, the records of the New York Central trains for this division will apply to trains of equal weight on the New York, New Haven & Hartford road, and were so considered in the calculations.

Description of Dynamometer Car—In the dynamometer car employed the draw-bar is secured by means of a suitable rod to a piston head which fits closely in a cylinder filled with oil. The pull at the draw-bar thereby produces a pressure upon this oil which is transmitted through suitable piping to the recording device, consisting essentially of a Bourdon gauge, which by means of a suitable arm and pen records upon paper, driven past it by gearing from the car axle, in such a manner that the height of the record from the base line is proportionate to the draw-bar pull. This base line, and time and position lines are produced by separate pens, the former recording every five seconds by means of clockwork, and the latter re-

* Abstract of a paper presented at the nineteenth annual convention of the American Institute of Electrical Engineers, Great Barrington, Mass., June 18 to 21, 1902.

cording at mile posts, stations, etc., when an electric circuit is closed by hand. The other instruments in use on the car during these tests were a Boyer speed recorder, an anemometer for recording the relative velocity of the wind, and a weather vane showing the direction of the wind relative to the direction of travel of the car.

The dynamometer cylinders are made of three castings held together by stud bolts. The effective area of the largest cylinder is sixty square inches, of the intermediate cylinder thirty square inches, and of the smallest five square inches. It is intended that the working pressure of the oil in the cylinder shall be from 300 to 1,000 pounds per square inch, and for this range of pressure the largest cylinder has sufficient capacity for the heaviest freight service, the intermediate cylinder would be used when working with a train of ordinary tonnage. If it should become necessary all the cylinders could be coupled up in multiple, thus giving an effective area of ninety-five square inches.

DISCUSSION OF RESULTS.

The questions of changes in the Grand Central terminal, or of the present method of train operation, or of handling the suburban trains on the division outside of Mott Haven Junction are not considered in this paper.

It appears that the braking effort per ton is not as high on certain types of locomotives as it is on coaches. This is due to the fact that not all the wheels of the locomotives are always braked, and those that are braked can not be set to the skidding point with a fully loaded tender, for if they were they would then skid with a lightly loaded tender. Hence the draw-bar pull during retardation is often as great or even greater than it is during acceleration.

METHOD OF OBTAINING HORSE-POWER AT DRAW-BAR FROM DYNAMOMETER RECORDS.

This was obtained in general in the following manner: From actual dynamometer car tests the average draw-bar pull of the various trains over the various runs was determined, proper allowance made for increased train weight due to motor equipment, and finally a reduction of the draw-bar pull thus obtained to horse-power, and eventually to kilowatts. Owing to the fact that the maximum speeds on this division seldom exceed thirty-five miles per hour and that the trains were never less than three cars in length—often reaching eleven cars in length—no correction was made for head-end air resistance.

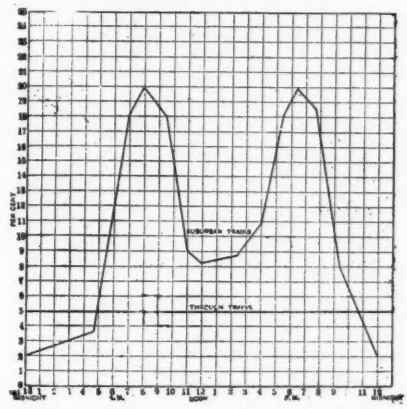


FIG. 1.—CURVE SHOWING RATIO OF LIVE LOAD TO LIGHT WEIGHT OF TRAIN.

The successive steps were as follows:

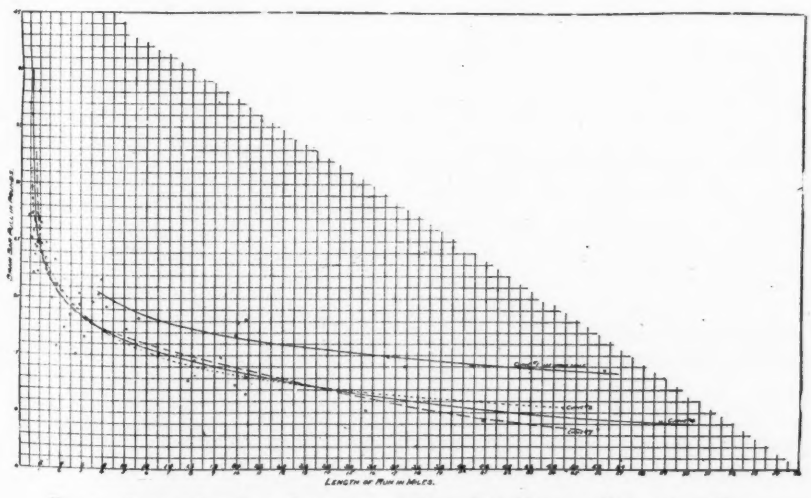


FIG. 2.—CURVES SHOWING RELATION OF DRAW-BAR PULL TO LENGTH OF RUN.

1. In order to determine the average draw-bar pull for any given period, the entire area under the dynamometer pen record was found by a planimeter and divided by the length of base of the interval from start to stop, the result being the average draw-bar pull. By dividing any area thus found by the total length of its base between stops, the average height of the dynamometer records between stops is obtained. This average height when multiplied by the constant of the instrument represents the average draw-bar pull between these stops.

2. From passenger records taken during dynamometer tests, the curve shown in Fig. 1 was plotted, showing the ratio of the weight of the live load to the light weight of the train.

3. Dividing the average pull in pounds by the total weight of the train, the average pound per ton draw-bar pull over the run under consideration, was obtained.

The average pounds per ton draw-bar pull (not tractive effort) for various lengths of run over the Mott Haven division are shown in curve 1 of Fig. 2. Curves 2 and 3 show these values for longer runs, as obtained on the Harlem and Hudson divisions, respectively, and curve 4, which is the mean of curves 1, 2 and 3, shows very roughly what may be expected to obtain as the average value of the "pounds per ton" draw-bar pull under ordinary steam railroad conditions, on a level and comparatively straight track, with various weights and lengths of train (three to ten cars, 100 to 400 tons), and at an average speed of about thirty miles per hour.

The question of grade is here eliminated, for each point shown represents the average value of two runs on the same train, one north, the other south.

The number of variables entering into these values, such, for example, as the degree of skill of the engineer, the wind velocity, the condition of the track, agreement with schedule time, etc., make it impossible for any curve to pass through all its points, and therefore, as above stated, these curves can only be taken as indicating the average value of a widely varying quantity.

4. A simple graphical method is made use of for obtaining the speed in miles per hour between any two stations where the time of run between these stations is given.

5. The weight of every train arriving or leaving the Grand Central Station on a given day was obtained, and its average speed between stops determined as described above. Knowing, therefore, the average draw-bar pull in pounds required to haul a train, and the average speed at which this draw-bar pull was exerted, the horse-power at the draw-bar becomes:

$$\text{H. P.} = \text{foot-pounds per minute}/33{,}000$$
$$= \text{draw-bar pull} \times \text{miles per hour} \times 5{,}280/33{,}000 \times 60$$
$$= \text{draw-bar pull} \times \text{miles per hour}/375$$

This formula is represented graphically

in Fig. 3, from which, knowing the draw-bar pull and speed, the horse-power or kilowatts corresponding thereto is determined. Thus, for example, if the draw-bar pull is 4,300 pounds, at a speed of thirty-six miles per hour, to find the horse-power or kilowatts corresponding thereto. At 4,300 pounds, on the ordinate at the left of the figure, follow the dotted line to the right until it intersects the required speed curve, thence downward to the base line thus obtaining 410 horse-power. If the efficiency of the motor is taken at seventy per cent, by following the ordinate at 410 horse-power vertically to the seventy-per-cent curve and thence to the left, the kilowatt capacity required is found to be 440 kilowatts, which is the power required to propel the train, exclusive of the locomotive and head-end resistance.

The horse-power required for each schedule train over each run was obtained in the same manner, and the results as taken from this table were plotted on train diagram sheets.

METHOD OF OBTAINING DAILY LOAD DIAGRAM.

From a careful examination of the weights of all locomotives now in service on this division it was found that properly powered electric locomotives having a total weight of sixty-five tons each, all of which would be available for tractive effort, could satisfactorily perform the service of existing steam locomotives.

To each train horse-power curve, therefore, as plotted on train sheets, is added the horse-power required to propel a sixty-five-ton locomotive.

This horse-power was obtained in the same manner as that required to haul the train and was plotted separately on the train sheets. Evidently the friction of an electric locomotive in pounds per ton is greater than an equivalent weight of train, but this difference was considered in selecting the proper locomotive efficiency.

The sum of the instantaneous values of these individual curves was then plotted. The mean height of this curve represents the average horse-power required to propel all schedule trains and locomotives during the period covered.

This average horse-power when converted into kilowatts by means of the following formula (which is exhibited graphically in Fig. 3):

$$\text{kw.} = \text{h.p.} \times 746/70\% \times 1{,}000$$

where 1,000 watts = 1 kw.
746 watts = 1 electrical h.p.
and 70% = efficiency of locomotives

gives the average kilowatt input required at contact shoes of electric locomotives for the period covered.

The switching, shop train and return engine service was found to represent such hourly demands as are shown in curves 3 and 4 of Fig. 4.

The sum of the mean average kilowatt input at contact shoes, and the mean kilowatts required for switching, shop train, etc., represents the average daily kilowatt input required at contact shoes of locomotive for all service.

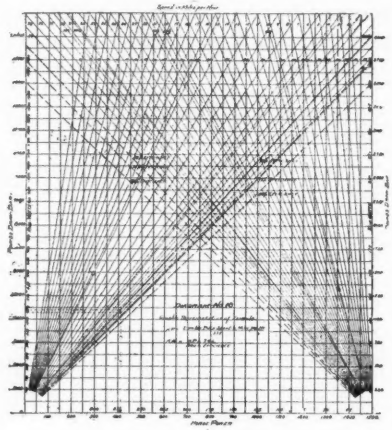


FIG. 3.—GRAPHICAL REPRESENTATION OF FORMULA FOR CALCULATING DRAW-BAR PULL.

Curve 1 of Fig. 4 is a condensed load diagram of the entire service, showing the hourly variation of the different classes of service as deduced above.

It was found that the daily average input required would be at the rate of 1,800 kilowatts and, therefore, the total annual input required at the contact shoes of the

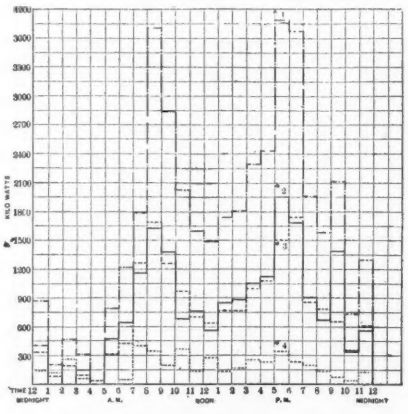


FIG. 4.—SERVICE LOAD DIAGRAM.

locomotives, for propulsion alone, would be (1,800 × 24 × 365) = 15,768,000 kilowatt-hours). From the total number of tons hauled yearly over this division, including passenger, shop trains and switching service, the ton-miles per year were found to be 250,285,710. Hence, the electrical energy required to haul a ton one mile over this division under the existing conditions would be 15,768,000,-000/250,285,710 = 63 watt-hours per ton-mile.

With this figure as a basis and the load-factor as determined from the load diagram, the problem of determining the best method of producing, distributing and applying the power was considered.

The concluding section of the paper was fully abstracted in the ELECTRICAL REVIEW, June 21.

NEW ELECTRO-PNEUMATIC SYSTEM OF ELECTRIC RAILWAY CONSTRUCTION.

BY B. J. ARNOLD.

During the past three years, as many of the members of the Institute know, I have advocated the use of the alternating-current motor for certain classes of railway work somewhat earnestly, and have often been asked by my friends why I believe so thoroughly in the alternating-current motor, and have been questioned rather closely at times for particulars regarding a certain system which I have been working upon.

I wish to state that long before I had any fixed ideas as to a system of my own, a study of the railway question from an engineering standpoint partially convinced me of the necessity of the ultimate abandonment of the direct-current motor for heavy and long-distance service, due to the low working voltage that it was necessarily limited to, the resulting heavy investment in transmission lines thereby required, and the many translations between the power station and the car when any great distance was taken into account.

An active connection with the development and construction of electric railways in this country impressed me with the correctness of my preconceived ideas to such an extent that they finally crystallized into a system of electric railway construction upon which I have been working for several years, and to which I have alluded from time to time without giving, to those not interested with me, any definite information regarding it, for reasons well known to those working upon new devices.

I have constructed twenty miles of road for this system, together with the necessary trucks and motor equipments, and as I feel reasonably sure of the interest you will take in this system, I feel warranted in presenting it to this Institute.

As I have previously stated before this Institute, I am particularly anxious that American engineers shall keep abreast with European engineers in the development of the alternating-current electric railway, and while some of my brother engineers may not agree as to the practicability of my

ideas, there are others in this Institute who I think believe as thoroughly in the alternating-current motor for railway work as I do, and whether my system proves the correct solution of the question or not, I firmly believe that the alternating-current motor will finally prevail for heavy railway work.

The recent discussions that have been going on between engineers in Europe and the United States of this question have made the subject a live one at present, and this is my reason for presenting a brief description of one embodiment of my system at this meeting.

The principles underlying the system I advocate and which I call an electropneumatic system, are as follows:

First—A single-phase or multiphase motor, mounted directly upon the car, designed for the average power required by the car, and running continuously at a constant speed and a constant load, and, therefore, at maximum efficiency.

Second—Instead of stopping and starting this motor and dissipating the energy through resistances, as is customary with all other systems known to me, I control the speed of the car by retarding or accelerating the parts usually known as the rotor and stator of the motor, by means of compressed air, in such a manner that I save a portion of the energy which is ordinarily dissipated through resistances, and store it to assist in starting the car, helping over grades, for use in switching purposes, and for the operation of the brakes.

Third—By this method of control I secure an infinite number of speeds from zero to the maximum speed of the car, which may or may not be at the synchronous speed of the motor, for with the air-controlling mechanism working compressing the speeds below synchronism are maintained, and by reversing the direction of the air through the controller speeds above, synchronism may be attained for reasonable distances. This feature gives to the alternating-current motor the element absolutely essential for practical railway work, for it permits a car or train to ascend a grade at any speed with the motor working at its maximum efficiency, and imparting its full power to the car. When descending the grade the motor may utilize its full power drawn from the line in compressing air, or it may be used to compress air with the stored energy of the train, thereby acting as a brake.

Fourth—By virtue of the air storage feature, each car becomes an independent unit and capable, in case of loss of current from the line, of running a reasonable distance without contact with the working conductor, and this without the aid of storage batteries. This feature will enable a car to work on a high-tension trolley wire or active conductor over private right of way, and allow the active conductor to be stopped where the private right of way ceases, and the car to proceed through a city or town on any tracks, whether electrically equipped or not, until it reaches the outskirts of the city or town where it can take up the working conductor again on private right of way. This feature is also valuable in switching work, for each car being independent it can leave the main line track and operate over switches or sidings without complicating the yards with additional overhead or third-rail conductors, thus necessitating through line conductors over main line track or tracks only.

Fifth—Since a single-phase motor can be supplied with current from a single overhead wire or third rail, and with a single rail return circuit, thus permitting the overhead construction, or third-rail construction, to conform to the standard of to-day, except that a much higher working voltage can be used, provided the insulation is taken care of. Furthermore, in steam railway work this system, by virtue of its single-phase feature, will only require the use of one of the track rails for the return circuit, thus leaving the other rail for the use of the signal system, which, up to the present time, does not seem to have been satisfactorily solved without the use of one of the track rails.

Sixth—The current will be taken from the working conductor at any voltage up to the limit of the insulation, and in case this voltage is high (I am building my line for 15,000 volts), a static transformer will be carried upon each car and the pressure reduced from the line voltage to the voltage of the motor, which in the case under construction is designed for 200 volts. Where it is unnecessary to utilize so high a line pressure the motor may be designed for the working voltage, and the current fed directly from the working conductor into the motor, thus eliminating the static transformer. When a high voltage working conductor and static transformer is used, and it is thought advisable to use a working conductor through cities or towns, this working conductor will be supplied with energy supplied through a stationary transformer at each city limit, thus making the working conductor through the cities or towns safe.

Seventh—By virtue of the speed of the motor and its constant load, either when the car is in motion or when it is standing still, and the motor is compressing air, the valuable load now customary in electric railway power plants is eliminated, and the power station works at practically a constant load, thereby eliminating a large part of the investment at present requisite in power station and line construction. Furthermore, by virtue of the air storage feature, each car, in the particular apparatus I have designed, is capable at any time when current is on the working conductor of delivering to the car wheels a much greater torque in proportion to the capacity of the motor than is possible with any electrical system known to-day.

I believe that by the adoption of this system the following results will be accomplished:

First—The entire elimination of the present standard system of rotary converter substation plant, together with the maintenance thereon, and the cost of the necessary attendants.

Second—The absorbing and rendering available for useful work in starting, or otherwise, a large percentage of the energy stored in the moving mass which under the present methods of operation is dissipated at the brake shoes.

Third—A large reduction in the first cost of electrically equipping long-distance railroads, thereby making it feasible, from an engineering and business standpoint, to equip many roads which can not now be shown to be advisable, thus opening up the steam railway field to the industry in which we are now engaged.

Coronation Honors to Men of Science.

Among the coronation honors recently announced, the following are of interest to our readers. Among the new privy councilors named are Lord Kelvin and Lord Lister. The honor of knighthood has been conferred upon Messrs. A. Cooper, Oliver Lodge, Arthur Rucker, John Thornycroft and William Ramsey. A new order of merit has been created, which includes the following names: Lord Rayleigh, Lord Kelvin and Lord Lister.

The National Electric Light Association's Report.

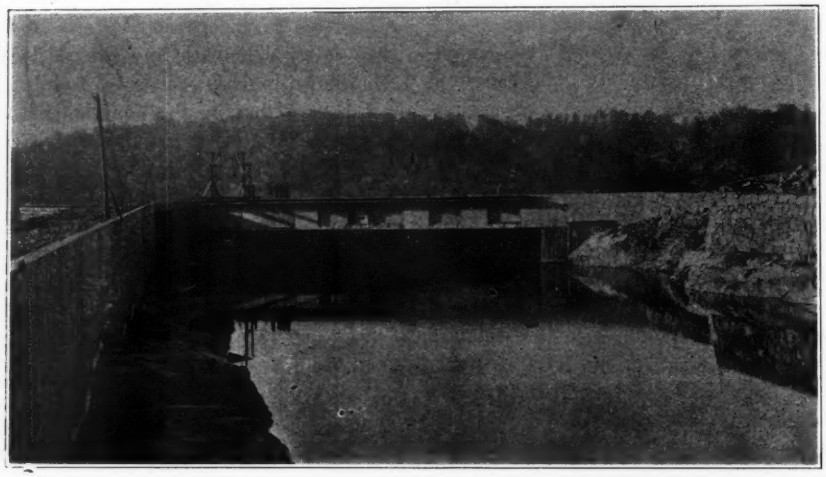
The National Electric Light Association's report of municipal lighting statistics has been issued and is ready for distribution to members only. This is a confidential report, and is not for general distribution.

The Hydro-Electric Power Plant at Shawinigan Falls.

A Complete Description of an Extensive Development on the St. Maurice River, Quebec.

By Frank C. Perkins.

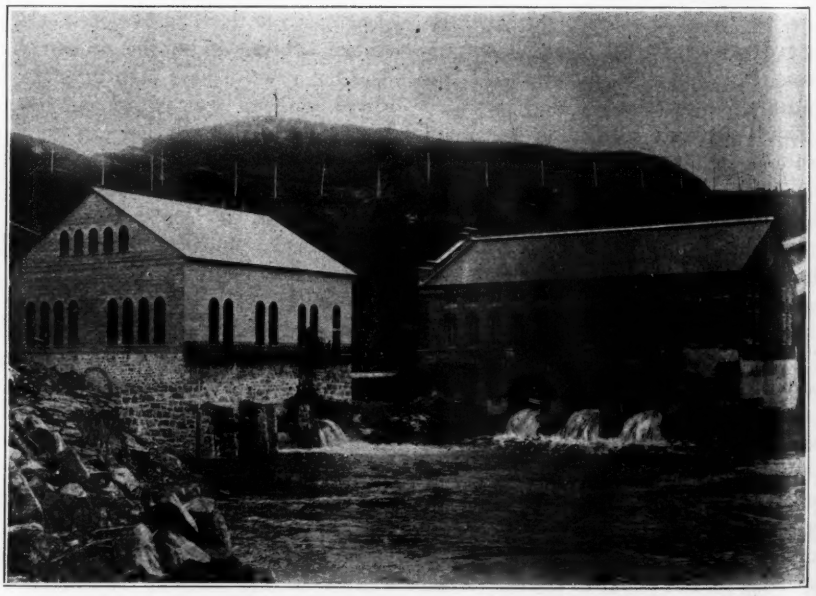
THE SHAWINIGAN FALLS power plant is now about completed and in successful operation, and although several thousand horse-power has been in use for some time, at each of the power-houses of the Belgo-Canadian Pulp Company, the Shawinigan Carbide Company and the Shawinigan Water and Power Company, there is abundance of power available, and this recent power development in Canada promises a great industrial and commercial future for the section about Shawinigan Falls.



THE FOREBAY AT THE SHAWINIGAN FALLS POWER DEVELOPMENT.

Mr. Wallace C. Johnson is the chief engineer of the plant, and he states that there is always a flow of water available sufficient for producing 200,000 horse-power at Shawinigan Falls or about 20,000 cubic feet per second. This hydro-electric power system obtains its water by a canal 1,000 feet long, 20 feet deep and 100 feet wide, and the water is carried through this canal to a forebay, formed by building a solid concrete wall or bulkhead from which the water is conducted through pipes to the power-houses 130 feet below. The concrete wall is 30 feet in thickness at the bottom and 40 feet high, and each pipe supplies water sufficient to develop 5,000 horse-power at the turbine and generator below. The canal has a capacity of 60,000 horse-power, although the present development is for only half that amount, with provisions for increased power as desired. When the power plant is working at its full capacity it will undoubtedly supply nearly all of the power used in Montreal and Quebec, which are 84 and 90 miles away, respectively, and the transmission lines to these important cities have already been laid out. There is no question but that a great manufacturing city will soon be located at Shawinigan Falls, where a number of industrial plants have already been established, attracted by the cheap power available, and a little city of several thousand inhabitants has already appeared which but two years ago consisted of but a few houses. Electric service from this power-house will also soon be delivered at Three Rivers, 21 miles from Shawinigan Falls, and also many towns and villages along the Great Nothern Railway between Quebec and Montreal.

The enormous power of the St. Maurice River has attracted the attention of promoters for a number of years, but the title to the property and water has been more or less complicated until recently, when the Privy Council of England decided that the provincial government could dispose of its water powers, and it has been selling these privileges recently with the understanding that the purchasers immediately commence the power development. On the Canadian side, at Niagara Falls, a great power-house is in course of construction, which will utilize turbines and electric generators of 10,000 horse-power each, with a total available capacity of 200,000 horse-power when ultimately completed.



POWER-HOUSE OF SHAWINIGAN WATER AND POWER COMPANY, AND POWER-HOUSE OF ROYAL ALUMINUM COMPANY. CAPACITY, 30,000 AND 15,000 HORSE-POWER, RESPECTIVELY.

The provincial government granted a charter to the Shawinigan Water and

Power Company, with the power to manufacture gas and electricity and develop the water power for the purposes of supplying light, heat and motive power, and to construct the necessary works for such purposes, as well as to transmit power generally throughout the province of Quebec, and to transmit electric power and sell it in the various towns and cities, with the right to appropriate land for its various purposes, including the necessary right of way to any point.

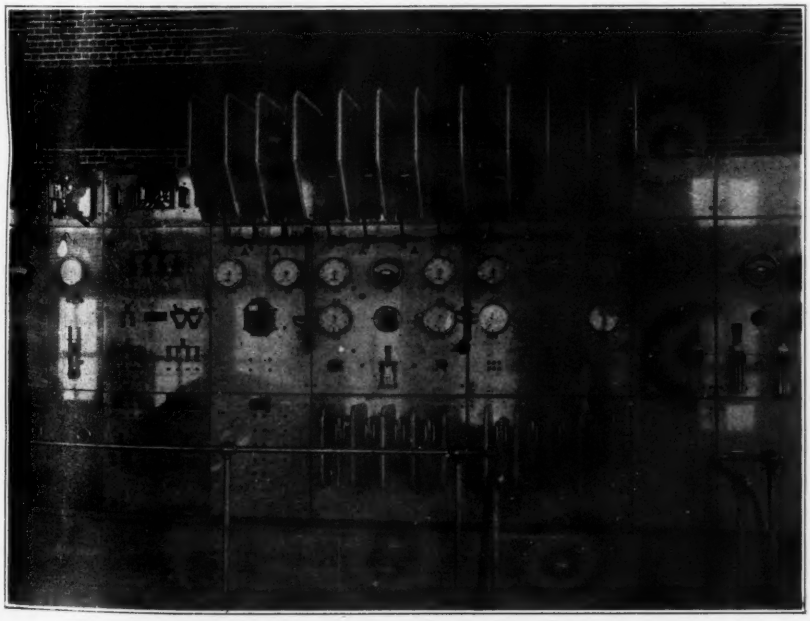
The St. Maurice River flows south and comes within about 1,000 yards of the falls, when its course is diverted by an island in the centre of the river to the west first and then to the north. The stream on the north side of the island is large and rapid and opens into a large bay after passing Melville Island, the area of which is more than 500 acres. There is a channel 600 feet wide, 20 feet deep and nearly a quarter of a m. long approaching the falls. The wate flows over a natural rock dam at the crest of the falls and then has a drop of about 100 feet to the south over a cascade, and finally the water rushes through a narrow gorge to the north into a lower bay of about 1,000 acres, the fall in the gorge being about 50 feet more.

The entrance to the 1,000-foot power canal, 100 feet wide, mentioned above, is near the crest of the falls, and at times of high water the ice is carried rapidly past the mouth of the canal. The St. Maurice is over 400 miles long and is supplied from a great many lakes and streams, and has 18,000 square miles of drainage area, and the flow of water is very steady on account of the dense forests covering this area.

A crib-work cofferdam was constructed at the upper end of the power canal for shutting the river out of the canal during construction, but was built only high enough to keep the water out at low stages of the river, during the winter, the upper end of the canal being excavated in the winter time; while nearer the forebay a higher crib dam was constructed across the canal, remaining during the summer, when the lower end of the canal and forebay were completed. The forebay wall which is 40 feet high and 30 feet thick at the bottom, as mentioned above, is only 12 feet wide at the top, where the hydraulic cylinders are set for lifting the headgates, while a brick gatehouse covers this machinery.

The steel tubing from the forebay to the power-house increases in diameter from 9 feet to eleven feet near the turbines, in order to reduce the velocity of the water before it reaches the wheels, and at about 50 feet from the power-house the thickness of the shell also increases from five-sixteenths inch to about nine-sixteenths inch, and each penstock is held against movement from expansion and contraction at the place it passes the power-house wall. A cast-iron bracket a foot thick encircles the penstock, being securely riveted to it, and fits closely to the wall, which is six feet thick where the penstocks enter the building, and then opens into the side of the case of a pair of water-wheels. The water enters the turbines radially from without, discharging radially toward the centre of the shaft into the draft chambers. The water-wheels in this main power-house were built by the I. P. Morris Company, of Philadelphia, and each has a capacity of 6,000 horse-power under a working head of 125 feet. The draft chambers of these turbines connect with an eight-foot draft tube which passes to the tail water, which has a mean low level of 25 feet below the centre of the wheel shaft. The turbine is controlled by gates in the draft chamber and is 30 feet long. Butterfly valves are used at the gates, closing toward the centre between the shafts. There are two large air chambers above the casing, which is of cylindrical form, 16 feet in diameter, while the runners which discharge through the central draft tube are six feet in diameter. The guide-chutes are made of cast steel and the runners of gun-metal bronze. The speed is regulated by a hydraulic governor controlling the gates in the draft tube, while the turbines may be started and stopped by a ring gate, which is provided on the outside of the guides, the latter being operated by an electric motor which is controlled from the switchboard gallery.

ONE OF THE PENSTOCKS AT THE SHAWINIGAN FALLS POWER PLANT—ELEVEN FEET IN DIAMETER.



SWITCHBOARD AT THE POWER-HOUSE OF THE SHAWINIGAN WATER AND POWER COMPANY.

A revolving field generator of the Westinghouse type is directly coupled to each water-wheel, which is of the "Francis" type, with horizontal shaft, and capable of developing 6,000 horse-power at a speed of 180 revolutions per minute. The alternators revolving at this speed generate an electric current of 2,000 volts poten-

tial and at a frequency of 30 cycles per second. Each of the alternators has a capacity of 3,750 kilowatts and supplies a two-phase current. At the switchboard the operator has complete control of not only the direct and alternating-current

INTERIOR OF POWER-HOUSE OF THE ROYAL ALUMINUM COMPANY, SHAWINIGAN FALLS POWER DEVELOPMENT.

machines but the turbines as well, which may be shut down at will by means of the electric motors controlling the gates as mentioned above.

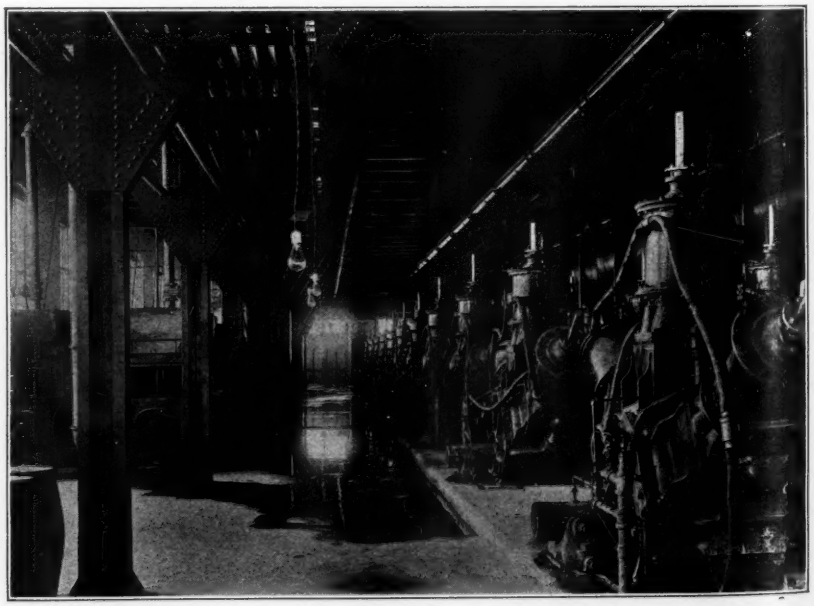
A 50-ton electric traveling crane was erected in the power-house even before the roof was completed, and the roof trusses were erected by using this as a falsework. The current for operating the electric crane, as well as the pumps, and the lighting of the buildings, was supplied by a direct-current generator of 500 horse-power capacity, driven by two water-wheels taking water from a small penstock. The pipe line now constructed at this power-house has a capacity of 15,000 horse-power, and the turbines and generators 10,000 horse-power, but it is expected that soon the entire 30,000 horse-power will be ready, and at no distant date 60,000 horse-power, the entire capacity of the canal will be used by establishments in the vicinity.

There is a large tract of land along the bank of the Shawinigan River, which is particularly well adapted for the building of mills, desiring to use the water power direct in wheels located in their own mills rather than have electric power furnished to them. This is particularly true in connection with the building of paper and pulp mills, and there are large quantities of spruce timber of the upper part of the St. Maurice water-shed.

In addition to the main water-power development at the power-house above described, it was decided to take advantage of the fact that at one point the Shawinigan River and the St. Maurice come within 1,000 feet of each other, but with a difference of level of 150 feet, and it was here on a point on the upper bay a second installation was made, and this is about half a mile from the main power-house of the Shawinigan Water and Power Company. This second installation was built by the Belgo-Canadian Pulp Company, whose enormous pulp mill is supplied with water for operating its turbines by the Shawinigan company. There is a few miles above this plant the largest paper mill in operation in Canada; and the Belgo-Canadian Pulp Mill turns out 10 tons of pulp per day, using for this work 8,000 horse-power, while an additional 7,000 horse-power, making 15,000 horse-power, will soon be used by another paper and sulphite mill. The pulp mill, which is in continual operation, is located on the lower ground, the headworks having been constructed on the north side of the upper bay and the water taken down through a narrow bank to the mill located on the Shawinigan River. It is intended to extend the works for other mills along to the west, and other factories which will locate further up the river.

A coffer-dam was first built in the construction of the works for taking water to this lower pulp mill. This dam was 250 feet long and was built out about 100 feet from the bank, and from each end a crib was built joining into the bank, and the inside part between the front crib and the bank was pumped dry. This intake was constructed of concrete, and the coffer-dam was constructed high enough to take care of high water, as the work was done in the summer months.

The concrete forebay, which is 40 feet high, is equipped with the necessary racks and head-gates, and from it the penstocks lead the water through the bank and down to the lower level, and after passing through the turbines discharging into the Shawinigan River as a tail-race. The penstocks are 12 feet in diameter, and a special tunnel 200 feet long had to be ex-



PAPER AND PULP MILL, SHOWING GRINDERS IN BELGO-CANADIAN PULP COMPANY'S MILL, SHAWINIGAN FALLS POWER DEVELOPMENT, USING 8,000 HORSE-POWER.

cavated through the clay bank. The steel frames supporting the racks and affording guides for the gates were complete by themselves, and they were erected before any concreting was done on the top of a grillage of steel beams and concrete forming the base of the whole structure. The turbines of 8,000 horse-power at the Belgo-Canadian Pulp Mill will soon be increased in number to a capacity of 15,000 horse-power, and 30,000 horse-power may be obtained when necessary by duplicating the crib and bulkhead next to the present one.

The power-house of the Royal Aluminum Company is at present equipped with two pairs of inward-flow turbines, developing 3,000 horse-power each, and the works have been built to accommodate three more pairs of wheels, making a total capacity of 15,000 horse-power. In the manufacture of aluminum it is necessary to have a direct current, and the voltage used by the Pittsburg Reduction Company, which is interested in this plant, is about 300 volts. As the aluminum reduction company desired to generate this form of current by generators and turbines under its own control, it built a power-house near the plant of the Shawinigan Water and Power Company and leased from it the water power delivered to the turbines. The two turbines of 3,000 horse-power each now installed at the Royal Aluminum Plant both take water from the same penstock and each is connected with a 78-inch valve, which shuts the water out of either wheel for repairs or inspection without interfering with the other. Each of the turbines is directly coupled to two 1,000-kilowatt direct-current generators.

The current is carried through a passageway 1,000 feet long on aluminum conductors three-eighths inch in diameter, to the furnace room in a building upon the hill, 400 feet above the power-house. The furnace building is 174 feet long, 20 feet high and 60 feet wide, and the reduction building is 276 feet long, 46 feet wide and 27 feet high. The four direct-current generators have a total capacity of 4,000 kilowatts and the two turbines driving them, built by the Dayton Globe Iron Works, have an output of 6,000 horse-power, which when taken with the power developed by the turbines of the carbide plant and the paper and pulp mills, will aggregate more than 35,000 horse-power.

An electric railway has been recently installed to take care of the present freight traffic, and electric locomotives are used for both passenger and freight service. Double overhead trolley lines are used and two trolley poles are employed for taking the current from the conductors to the motors of the motor car.

ELECTRICAL MINING NOTES.

BY SIDNEY F. WALKER.

A LARGE THREE-PHASE ELECTRIC PUMPING PLANT IN A GERMAN COLLIERY.

The Lahmeyer Company, of Frankfort on Main, has put down a large three-phase plant at the Zollverein colliery, at Catenberg, near Essen, entirely for pumping. The mine is over 400 yards deep, and the pump raises 673 gallons of water, a total of 1,350 feet. The generating plant consists of a flywheel, three-phase alternator driven by a vertical tandem-compound engine, the alternator furnishing 300 kilowatts at 1,000 volts between phases. The current is conducted down the mine shaft by two concentric armored cables, supported about every 315 feet by iron cleats, wood-lined. The motor is rated at 350 horse-power, and is directly connected to the pump, running at 60 revolutions per minute. The pump is of the duplex, differential type, its plungers being about 5 inches and 7 inches in diameter, with a stroke of about 40 inches. The motor weighs 30 tons, and was taken down the mine in pieces, being put together and erected there. The current is led to the motor at the full pressure of 1,000 volts and 25 periods. The diameter of the stator of the motor is 15 feet. The engine on the surface indicated 426 horse-power when the pump was raising its 673 gallons 1,350 feet, giving an efficiency between the cylinder of the driving engine and the power actually expended in the water of over 60 per cent, a remarkably good performance, as many pumps which are used in coal mines do not have a higher efficiency than that, without taking into account any losses in transmission, and in the conversion of the energy used in driving the pump.

ANOTHER NEW PORTABLE ELECTRIC MINER'S LAMP.

A Berlin firm has brought out another portable electric lamp for mines, which is stated to have been tested in the Konig colliery, near Saarbrucken, with good results. It consists of the now usual accumulator with which we are so familiar, but it is stated that two sets of cells are carried, and in one form of the lamp two incandescent lamps, so that if one goes out the other can be switched on. The lamp with two glow lamps weighs 6 pounds, and that with only one, 5 pounds.

The double lamp, as it is termed, costs 35 shillings, and the single lamp 30 shillings, or the equivalent in German money. At the test it is stated to have given from 10 to 15 hours' light, the pressures at the lamp terminals varying between 4.5 and 4.25 volts during the test, and the light given between 1.2 and 1.5 candles. A test was made at the colliery mentioned, with the lamp in an explosive atmosphere, carrying the lamp rapidly through the air, and breaking the glass of the glow lamp, but no ignition of gas resulted.

OPENING OF THE SOUTH WALES ELECTRIC POWER SCHEME.

The South Wales electric power scheme is interesting to those who are engaged in mining work, as it hopes to derive a large portion of its revenue from collieries within its area. It proposes to lay down four power stations in different parts of the industrial area. The industrial area in South Wales is comparatively small. The largest portion is confined to the principal coal basins, and may be taken to lie within the space bounded by Newport on the east, Swansea on the west and Merthyr and Aberdare on the north. Pontypool and Pontypridd are the centres of the Monmouthshire and Glamorganshire coal areas, though there are outlying portions further to the west. The power stations to be put down are—one in the neighborhood of Pontyridd, which is actually in progress, one at Pontypool, one near Newport, and one at Neath on the west, the last being to supply the western district. To the west, again, of Swansea there is the tin-plate town of Llanelly, and some smaller coal mines.

Not much has been done in South Wales, in the towns, to provide electric facilities, Swansea, Cardiff and Newport being practically the only towns whose corporations have provided electric generating plants, and those not making a good show.

Merthyr has a traction plant, also supplying light, owned by a private company, and Penarth, a suburb of Cardiff, is laying down a lighting plant. The South Wales Power Company has been warned off the towns unless it keeps the price up to a certain figure.

Nearly every colliery in the district has its own lighting plant, and several have their own power plant, though power transmission has not been carried out to any great extent in the district. The idea of the power company is to supply current to work the collieries and other industries at a cheaper rate than they can generate it for themselves even by burning coal under their own boilers.

The Trafford Park estate, near Manchester, which is being worked on these lines, supplies current in any form, the

writer is informed, at three farthings per unit, which may be taken to mean three farthings per horse-power in the motor. Probably most collieries are paying more than that for their power at present, but it is by no means certain that the large collieries could not beat anything that an outsider could do with their own plant. In South Wales the idea is, the writer believes, to supply current at the pits at a charge of three half-pence per unit. This latter figure will look very large to American engineers.

ELECTRIC POWER DISTRIBUTION IN SOUTH AFRICA.

Distribution of power by electric currents is likely to take an important place in the development of South Africa after the peace. There is coal in abundance, but, as often happens, it is not in many cases conveniently situated for the gold mines, and the question arises whether it is cheaper to transport the coal by rail and burn it, usually without the best economy, at the mines, or to burn it at the collieries and transmit the energy by electric currents. Where railways are necessary, for other reasons, between the collieries and the neighborhood of the gold mines, it may be an open question which is the most economical plan, but where, as in some cases, the coal mines lie off the track, and any lines connecting with them need not necessarily touch the gold fields, there will be no possible doubt of which is the most economical.

Coal is not the only source of energy available in South Africa. Already some of the mines in the outlying districts of the gold fields are being worked entirely by electrically transmitted power, furnished originally by water.

AN EXPLOSION IN A SINKING SHAFT, DUE TO AN ELECTRIC SPARK.

An explosion occurred a short time since, at a colliery in Lancashire, in a shaft which was in process of sinking. It is a case which has not, to the writer's knowledge, occurred before. It is usual now, when shafts are being sunk, to light the sinking by means of electric incandescent lamps, arranged in a group, under a large enameled iron shade, the current being supplied from a dynamo on the surface by means of cables which follow the sinking, as it descends. This is about the roughest work that electric light is put to, and the cable should be specially protected, but it is very rarely that this precaution is adopted, so that the cables are subject to frequent accident. It is not often either that gas is found in a sinking shaft in explosive proportions. The ventilation of a sinking shaft is usually very good, and in addition, any feeder of gas which is tapped is usually soon walled back by the regular shaft walling, or where it is a seam "to be worked from which the gas issues, it is got rid of by other means."

In the present case, however, the sinking had recently passed through a seam which gave off gas, and it had not been walled back. Also it appears that the lighting cables had been treated more harshly even than is usual in a sinking shaft, and they were bare in places. There were also in the pit a good many foreigners who did not understand the language, and who were not acquainted with the serious consequences of allowing a spark to pass in an explosive mixture of gas and air. One of them, it is stated, either by accident or for mischief, touched the two bare cables with the blade of his pick, a spark resulting, and the gas which was present being fired, with the result that several men lost their lives. The usual lesson is wanted—care.

Manufacture of Electro-Steel in Sweden.

At the meeting of the Iron Manufacturers' Association (Brukssocieteten), at Jernkontoret, recently, Engineer F. A. Kjellin and Mr. Benedicks gave some very interesting information about the production of electro-steel at Gysinge.

The problem of smelting steel by electricity, writes Consul Robert S. S. Bergh, of Gothenburg, has for a long time attracted the attention of inventors, and experiments have often been made here. By the advice of Engineer Kjellin, Mr. Benedicks decided, in 1899, to build at Gysinge an electric steel furnace without electrodes.

In the latter part of February, 1900, the first furnace was finished and ready for trial, and after a few experiments the first ingot was produced. The steel was found to be of excellent quality. The problem was thus solved technically, but not economically, for, with the dynamo of 78 kilowatts used, not more than 270 kilogrammes (575 pounds) of steel were obtained in 24 hours, and in the furnace there was not room for more than 80 kilogrammes (176 pounds). A larger furnace was seen to be necessary, and this was completed in November, 1900, and proved to be a great improvement. In the second furnace, which held 180 kilogrammes (397 pounds), from 600 to 700 kilogrammes (122 to 134 pounds) of steel were produced in 24 hours. The Gysinge sulphite factory burned down on August 11, 1901, and it was decided to build steel works in its place and to use the water power available there. For the steel furnace there was utilized a turbine of 300 horse-power, with direct-coupled generator. The new furnace is to hold 1,800 kilogrammes (3,970 pounds), and the production is estimated to be at least 1,500 tons a year if charged with cold raw material.

Engineer Kjellin said that the steel produced is of superior quality and characterized by strength, density, uniformity, toughness, and the ease with which it can be worked in cold, unhardened condition, even when containing a very high percentage of carbon. Compared with other steel, it also has less tendency to crack or warp when hardened.

The reason why this steel, in certain qualities, differs from other steel, especially in its softness when unhardened is considered to be its freedom from gases. The manufacture of special steel, with nickel, chrome, manganese, or wolfram, will, of course, not meet with any difficulties. The chrome steel and wolfram steel produced at Gysinge have proved to be excellent for lathe tools. When used for permanent magnets the Gysinge wolfram steel has been found to give stronger magnets than other wolfram steel, and has not warped in the hardening.

From estimates made it has been ascertained that the furnace used at Gysinge, which is simple in construction and easily managed, has prospects of competing, as to cost of operation, with the furnaces heretofore used for fusion of steel, especially as it yields steel of a better quality.

For this country, with its good ores and large supply of water power, the electric method of smelting steel ought to be of great importance, and abroad, where blast furnace gas is becoming a cheap source of power, it ought to come into extensive use.

After the lecture Engineer Wahlberg made some statements concerning tests of steel ingots from Gysinge, which had been found to be uniform and homogeneous. Microscopic examinations had indicated that there was no difference between the electro-steel and crucible steel, which was so much more remarkable as the electro-steel in other respects had different qualities.

The expression in the catalogue "weight per mile per ohm 5,600 pounds," means that a wire one mile long and having a resistance of one ohm would have the specified weight.

THE CONSTRUCTION OF TELEPHONE EXCHANGES—XXXIII.

BY A. E. DOBBS.

In order to get the same magnetic effect, the two outside coils should also have 2,000 turns—1,000 at each end of the core. But 2,000 turns, outside of the others,

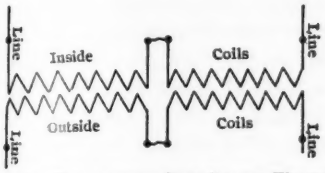


FIG. 137.—REPEATING COIL-SPLIT WINDINGS.

would almost double the length of wire and greatly increase the resistance. However, this can be balanced in another way, as shown in Fig. 138. In this case is represented the way that battery is generally fed into the induction coils of a central battery system, and the two coils are cross-connected instead of being in series, as in Fig. 137. Thus one inside coil is connected to one outside coil at the opposite end, and *vice versa,* and, as the four coils are as nearly equal as it is possible to make them, this produces a perfect electrical and magnetic balance, and constitutes an ideal method for connecting coils together. In patent office diagrams this coil is generally shown, as in Fig. 139; in other diagrams it is sometimes called a Y-winding. The use of repeating coils between lines of different

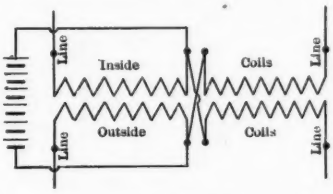


FIG. 138.—COILS CROSS-CONNECTED INSTEAD OF IN SERIES.

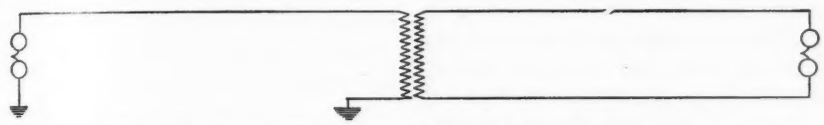


FIG. 140.—GROUNDED LINE AND METALLIC CIRCUIT CONNECTED.

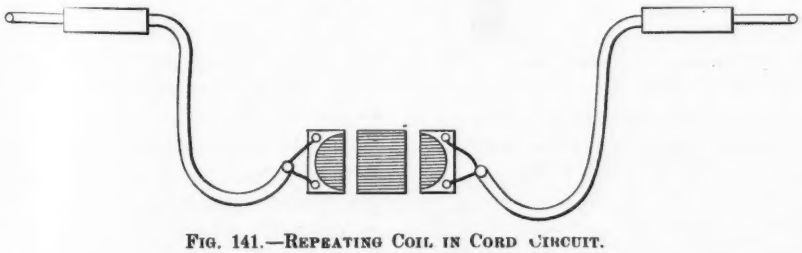


FIG. 141.—REPEATING COIL IN CORD CIRCUIT.

length is made necessary by the fact that if a grounded line, for example, is connected to a long metallic circuit line, there will be an unbalancing of the circuits that will make conversation difficult, if not almost impossible. The quieting effect of a repeating coil consists in the fact that each circuit ends at the coil, and the repetition from one line into the other does not unbalance the lines connected in this way.

A grounded line, for example, might be quiet when joined to another line of the same kind and the same length. A common return line or a leaky toll line might give very satisfactory local service, but when joined to a very long metallic circuit line the static capacity of the long line completely overbalances the shorter with the result above stated. For this reason, when circuits are to be connected together, as from a local grounded or common return circuit to a long-distance circuit, the connection is generally made through a repeating coil, as shown in Fig. 140. For the sake of simplicity, the cord circuits connecting with the toll section of the board are often connected to a repeating coil, as shown in Fig. 141. It is not necessary that this repeating coil should be balanced, for it is generally joined in series, as is shown in Fig. 137, the winding in that case being probably 125 ohms on one side and 200 or 250 ohms on the other. A combination that gives a difference of 175 and 250 ohms is frequently used in this connection. Still there are many cases where a permanent connection with a cord circuit is not considered desirable, as many people connected to a local exchange will have metallic circuit lines which are best connected through without the intervention of a repeating coil, which always interferes to a certain extent with the clearing-out signals. Therefore, the connection is often made, as in Fig. 142, where a repeating coil is thrown in by means of a special key. When the operator connects to a short toll line, she does not use the repeating coil at all, but with a longer one, however, should she find it noisy, she depresses the key and puts the repeating coil in circuit, which gnerally improves the service by quieting external disturbances.

The advantage of this system is that it leaves the cords free to connect with other parts of the board, if desired. Figs. 143 and 144 show a repeating coil made by a well-known manufacturer, which has been very carefully proportioned. The core is surrounded by a tube of hard fibre, and the insulation further carried out by hard fibre washers, one in the middle and two at the end. In order to complete the magnetic circuit, an iron cap covers the end which connects with a piece of wrought-iron pipe, which covers the entire core, making it water-proof as well as fire-proof, ensuring a magnetically closed circuit. It will be seen that there are four winding spaces, one at each end of the

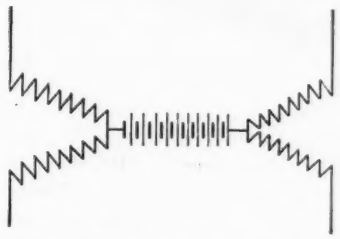


FIG. 139.—CENTRAL BATTERY COIL CONNECTION.

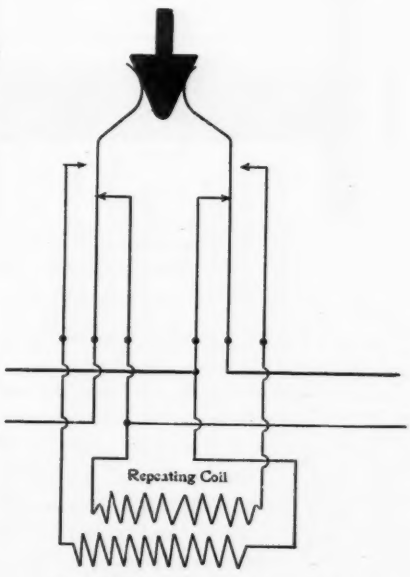


FIG. 142.—REPEATING COIL KEY.

core. The ends of the winding are brought out through holes in the end of the iron cap, both front and rear, and can be cross-connected in any desired manner.

The proportions of this coil are as follows:

Depth of winding, ¼ inch; space inside of case, 5¾ inches; thickness of fibre heads, ¼ inch; thickness of fibre middle division, ⅛ inch; diameter of fibre heads, 1 1/16 inches; diameter of fibre core (outside), ⅝ inch; length of winding spaces, each, 2 7/32 inches; depth of each winding, ¼ inch; average diameter of

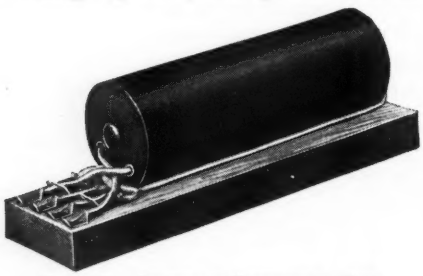


Fig. 143.—Ironclad Repeating Coil.

windings (outside coil), 1⅜ inches; average diameter of windings (inside coil), ⅞ inch; size of wire No. 30 B. & S. G., single-cotton covered; number of turns in each layer of winding, 160; number of layers in each coil, 18; total number of turns, each coil, 2,280; number of feet in each winding, outside coil, 1,036; number of feet in each winding, inside coil, 600; resistance, outside coil, 107 ohms; resistance, inside coil, 68 ohms; total resistance, when both sets of windings are connected together in series; outside coils, 214 ohms; inside coils, 136 ohms.

Understand, that this is a repeating coil built for toll-line work and the resistance of its windings is therefore likely to be much higher than those used in central battery work, although the frame and general dimensions of the coil remain the same.

Other coils used in central battery work vary considerably from this standard, coarser wire sometimes bringing the resistance of each side as low as twenty ohms, but that is a matter of detail for manufacturers to work out, as each system requires its own special devices.

The Results of the Reichsanstalt Tests of the German Nernst Lamp.

The Allgemeine Elektricitäts Gesellschaft, Berlin, give the following results of tests made by the Reichsanstalt with their model of the Nernst lamp. The lamps tested were of model B, one with a straight luminous filament and the other with a bent luminous filament. The tables give the figures obtained for the two kinds of lamps.

I—LAMPS WITH STRAIGHT LUMINOUS FILAMENT. MEAN OF FIVE LAMPS. TENSION 220 VOLTS.

Duration of Test. Hours.	Current. Ampere.	Candle-Power. Candle.	Decrease in Candle-Power.	Energy Consumed per Candle. Watts per Candle.
0	0 264	35.1	0 %	1.65
50	0.261	32.4	7.7 %	1.77
100	0 260	32 3	8.0 %	1.77
290	0.253	30 1	14.0 %	1.85
300	0.?42	27.5	21.6 %	1.93
400	0.237	26.5	24.5 %	1.97
Mean during 400 hrs.	0.251	30.1	.....	1.83

Of the five lamps the filament of one burnt out after 310 hours, of another after 379 hours, the three remaining filaments being intact at the end of 400 hours. The mean longevity of a filament thus exceeded 378 hours. The heating spirals were uninjured.

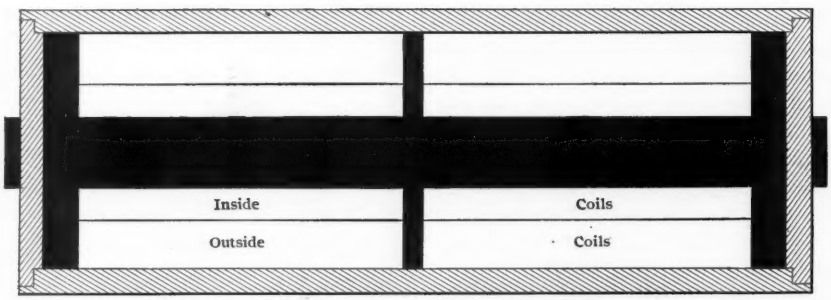


Fig. 144.—Sectional View of Figs. 137, 138 and 139.

II—LAMPS WITH BENT LUMINOUS FILAMENTS. MEAN OF FIVE LAMPS. TENSION 220 VOLTS.

Duration of Test. Hours.	Current. Ampere.	Candle-Power. Candle.	Decrease of Candle-Power.	Energy Consumed per Candle. Watts per Candle.
0	0.259	40.1	0 %	1.42
50	0.259	36.3	9.5 %	1.57
100	0.259	38.1	5.0 %	1.49
200	0.247	34 1	16.0 %	1.59
300	0.238	33.2	17.2 %	1.58
400	0.219	27.6	31.0 %	1.75
Mean during 400 hrs.	0.245	34.4	.....	1.57

Of the five lamps one of the filaments gave way after 150 hours, the other four were intact after 400 hours. The mean longevity, therefore, exceeded 350 hours. The heating spirals of two lamps gave way after 110 hours and 395 hours. The mean longevity of the lamps, having regard to the heating spirals, is, therefore, 291 hours. The lamps, of which the measurements are given in table I, are at present in the market. Those lamps to which table II refers are in preparation, but the A. E. G. are not yet able to specify a date at which they will be able to supply them. The present demand for Nernst lamps has already necessitated large additions to their factory.—*Electrical Review* (London), July 4.

Book Review.

"Konstruktionstafeln für den Dynamobau." Professor E. Arnold. Price, Part 1, 40m. 20pf.; Part II, 40m. 20pf. Published by Ferdinand Enke, Stuttgart. Size, 15½ by 20¼ inches.

These works consist of two portfolios containing plates showing the details of design and construction of various types of dynamo-electric machines.

One portfolio—Part I—contains drawings relating to continuous-current machines, and in the other—Part II—the plates and diagrams are all of alternating-current machines.

Part I consists of 60 plates which give designs of 41 continuous-current machines of nearly every standard type and ranging from 3½ to 1,000 kilowatts in size. All drawings are to scale, and an extensive table which accompanies each folio gives the principal data concerning each design, the chief dimensions, winding data and calculated constants all being included.

There are numbers of drawings of detail parts such as commutators, brush-rings and yokes, brush-holders and field-magnet frames.

Part II contains designs of 29 generators of from 20 to 1,500 kilowatts output, 9 rotary converters, 13 asynchronous motors and 8 transformers, besides detail drawings of armature sections, field frames and arrangement of pole-pieces, exciters and methods of driving. A complete table of data such as accompanies Part I is also included.

It is undoubtedly a useful and valuable addition to the literature of dynamo-electric machinery, though with only two exceptions in Part II the practice, designs and methods given are exclusively those of continental Europe.

ELECTROLYSIS AGAIN.

To the Editor of the Electrical Review:

I note in recent issues of some prominent New York newspapers some editorial comments and letters criticising your editorial of July 5, concerning electrolytic action in pipe systems. The opinions therein expressed are typical of those written from a gas and water-pipe standpoint, and, like most newspaper articles on technical subjects, can hardly pass any scientific controversy. However, they undoubtedly voice some popular misconceptions of electrolysis, and a few remarks may therefore be in order.

Electrolysis of gas and water pipes occurs in the following way: The electric current from trolley cars, in endeavoring to return to the power-house, enters the piping system, which it traverses according to the laws of the path of least resistance. At the point where it leaves the pipe it creates electrolytic corrosion. Plainly there are two ways of stopping this. One is to prevent the current from leaving the pipe under electrolytic conditions, and the other is to keep it out of the pipe altogether. Unfortunately the methods by which these results are attained are in direct opposition to each other. To mix them is worse than mixing homeopathy and allopathic practice; and as most embryo engineers are (partly) familiar with the mixture only, it is not surprising that discussions on this subject are participated in by many irresponsible communicants who base short-sighted conclusions on what they have seen, and who seem utterly incapable of looking at the subject in a scientific, broad-minded way.

A New York *Times* editorial ventures to criticise your suggestion of breaking up the continuity of water and gas pipes by insulating joints to avoid electrolytic troubles therein. Our lay-writer is moved to ask when electricity is destructive of a good conductor and conservative of a poor conductor. He supposes that the good conductor is the only one never injured by an electrical current, and he states that if this assumption is not correct he will have to revise his judgment on nearly every subject of electricity. While it is to be hoped that such a step will not be necessary, for it might be radical, I fear that if he wishes to avoid sophistry he will have to confine his remarks to the issue. He seems to have lost sight of the fact that the scheme proposed in your editorial, of making the pipe return a poor conductor, is not to make the metal immune to electrolysis, but to keep the current out of it. Electricity has a habit of flowing in diminished volume in poor conductors, other things being equal, and electrolysis is directly proportional to the volume of flow and the time during which the flow occurs.

Of the two methods of preventing electrolysis previously referred to, one is to make the pipe line an absolutely continuous metallic structure and connect it solidly to the return feeders at all points where current tends to leave it. This, of course, invites large currents to enter the piping systems and leave it at the points thus protected. This is rarely satisfactory as the current distribution is continually changing with the position of the cars.

The other plan is that suggested by your editorial, namely, to break up the electric continuity of the piping system so thoroughly that currents will not enter it, but will by Ohm's law remain almost entirely in the rail return.

One broken joint in the pipe line carrying a heavy current is the seat of formidable electrolysis. This is as far as many students of the subject go. They assume that another break would present equal trouble, and therefore condemn insulating joints, forgetting that each instance of electrical discontinuity reduces the current, and with it the electrolysis, thereby dividing instead of multiplying the damage. A sufficient number of good insulating joints, supplemented by complete disconnection from the rail return and insulation of the body of the pipe itself, will reduce the current so that the electrolytic effect is trifling. These are matters of positive practical experience.

The piping companies loudly insist that the railway companies shall reenforce their rail returns and bond their rails tightly together, alleging, and very truly, that unless this is done the current will enter their piping systems. They fail to appreciate that the converse is equally true, and that if the electrical continuity of their piping systems is broken up, the current will remain practically *in toto* in the continuous metallic returns to the power-house. It is very natural for the pipe company experts to advocate the method that makes the least work for them, and to ridicule the expedients of the other school by relating perfectly truthful instances of their inefficiency in cases of mixed method; and as seeing is believing without qualification, the lay-mind is profoundly impressed, and it is surprising how quickly a profoundly impressed layman clothes himself with the dignity of expert authority.

Further on, the newspaper editorial gives a description of the electrolytic phenomenon which, to say the least, is original. The editorial writer says that "the conductivity of wet ground is so nearly that of cast iron that very little resistance in shape of a break in the continuity in the best conduction which a pipe line is capable of offering will cause a current to leave it, snapping off in sparks. [!!] Each spark is a miniature arc, with a base of intense heat. It is there that the phenomenon of the electrolytic destruction takes place." This is certainly an effusion worthy of the Limekiln Club.

Let us for a moment revert to the facts in the case. Electrolytic action is a simple and quiet chemical decomposition, taking place very much like the dissolving of metal in an acid, and without pyrotechnics of any kind. It is proportional to the volume of current and to the time that it flows. It will attack any conductor, either poor or good, at the point of leaving if the conditions are such as to invite electrolytic action. It can be effectively checked by making nil the volume of current flowing. This, as your editorial very correctly states, can be done by thoroughly breaking up the electrical continuity of the piping system. A partial attempt to do this will be worse than to leave the metallic continuity intact, and the experience and judgment of most of the newspaper communicants seem to be drawn from such cases, which are frequent in practice. If the conductivity of wet grounds were nearly that of cast iron, it is probable that there would be little choice between the iron pipe and the ground, which would make the construction of insulating joints difficult. Unfortunately, the most conducting loam saturated with salt-water measures about 20 ohms to the cubic yard, while a cubic yard of cast iron, specially alloyed for high resistance, has a resistance of about 0.0000011, making the conductivity of cast iron almost twenty million times as great as that of moist conducting earth.

The writer of the newspaper article recommends as an insulating joint the hub and spigot joint packed with rope yarn and lead, lead being suitable as an insulator by reason of its low conducting powers! Asserting that such joints exist in piping systems, he points out the fact that the electrolysis is not checked. While such a joint is a relatively poor conductor for return currents, it is by no means an insulator, and will permit large currents to flow through it to its own detriment; in short, it well illustrates the effect of a partial application of the one method in a system primarily equipped for protection by the other plan.

These newspaper articles are, however, valuable and should be studied with care, for they are the gospel of many and show the street railway engineer the character of expert opinion with which he has to deal.

George T. Hanchett.

New York, July 12.

"THE DISSIPATION OF ENERGY BY ELECTRIC CURRENTS INDUCED IN AN IRON CYLINDER WHEN ROTATED IN A MAGNETIC FIELD."

BY ERNEST WILSON.*

The effect which induced electric currents have upon the distribution of magnetism in an iron cylinder, when rotated in a magnetic field, has formed the subject of communication,† and it is the object of this paper to deal with the energy dissipated by these electric currents.‡ A comparison will be made between the results of experiment and theory. In connection with the latter, I have to thank J. B. Dale, Esq., M.A., assistant lecturer in mathematics, King's College, London, for a contribution which at his wish I append to this paper. The cylinder used in the experiments has diameter and length each ten inches (25.4 cm.). Since the previous experiments were made, additional holes have been drilled in a plane containing the longitudinal axis of the cylinder, and its present section is shown in Fig. 1.

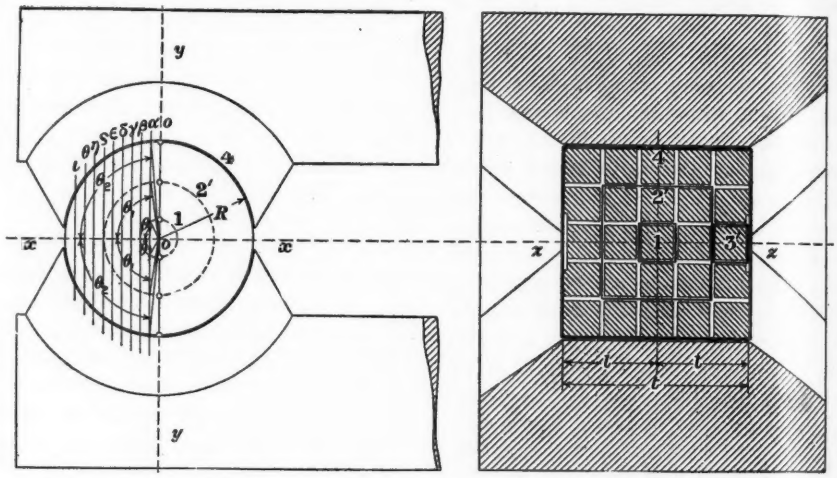
Insulated copper conductors have been threaded through these holes, and enclose areas indicated by the thick lines in Fig. 1. The coils are numbered 1, 2′ and 4, and enclose areas of 25.8, 232 and 264 sq. cm. respectively. As in the previous experiments, the electro-motive force in each coil has been calculated from the observed deflection of the needle of a D'Arsonval galvanometer placed in each circuit. The deflections were observed simultaneously, thus enabling the relative phase-displacements to be determined.

SPECIFIC RESISTANCE.

The specific resistance of the material of the cylinder has not been directly determined. The late Dr. John Hopkinson gives 10.5×10^{-6} ohms for mild steel,§ and I have used 10×10^{-6} ohms in connection with the cylinder. A remarkable case of high specific resistance, combined with high magnetic permeability and relatively small dissipation of energy by magnetic hysteresis under alternating magnetic force, is an alloy of iron and aluminum,‖ in which the specific resistance is 39×10^{-6} ohms. Provided it keeps its good qualities after prolonged use, this alloy should prove of great value.

EXPERIMENT.

The rate at which energy is being dissipated by electric currents induced in the cylinder, has been obtained in the following manner: The horizontal radius in Fig. 2 has been divided into ten equal parts and the cylinder is supposed to be cut by vertical planes 0, α, β, γ . . . passing through the points of intersection, the plane 0 containing the axis of the cylinder. The circles 1, 2′, 4 show the paths traversed by the longitudinal sides of the exploring coils during rotation of the cylinder. In the plane α let θ, θ_1, θ_2 be the angles which the plane of the exploring coils makes with the horizontal when the coils 1, 2′ 4 have respectively one of their longitudinal sides in the plane α. Three paths of induced electric currents of the plane α are now assumed. No. 1 is taken to be the rectangle having its two sides, which are parallel to the longitudinal axis, equal to and coinciding with the sides of the coil, and its two other sides the straight lines necessary to complete the rectangle in the plane α. Similarly with regard to coils 2′ and 4. Each path is assumed to have a cross-sectional area of one sq. cm. throughout its longitudinal length, and this area multiplied by the sine of the angle which the plane of the coil makes with the horizontal, throughout the remaining portion of its length. The electric resistance of each path has been calculated in ohms. Fig. 3 gives a set of curves obtained with 360 seconds periodic time, and maximum average induction 19,900 C. G. S. units per square centimetre for No. 4 coil. The curves give the electro-motive forces in volts per turn for coils 1, 2′ and 4 respectively. The electro-motive force of No. 1 coil at angles θ on each side of the point 0, where the curve cuts the axis of time, has been halved, and the sum of the values thus obtained is taken to be the effective electro-motive force in volts acting around the assumed path of the induced electric current. Similarly for 2′ 4 at angles θ_1 θ_2 respectively in Fig. 3. The rate of dissipation of energy in watts is taken to be the square of this electro-motive force in volts, divided by the resistance of the path in ohms. These watts have been plotted on square paper, and the total watts in the plane α have been obtained by integration with respect to the vertical distance from the horizontal axis. Finally, by integrating with respect to the horizontal axis ox, the total watts dissipated in the half cylinder have been found. The figures thus obtained at periodic times, 45, 90 and 360 seconds, for general value of the total flux of induction between the pole pieces, are set forth in table I. Strictly this method is only applicable when the electro-motive forces of coils 1, 2′ and 4 are in phase. With a periodic time of 360 seconds the curves are nearly in phase for all values of the external magnetizing force, but this is not the case for the other periodic times, except at the high forces. The electro-motive-force curves are assumed to be in phase in each experiment when applying the above process of integration.



FIGS. 1 AND 2.—SHOWING DIAGRAMMATICALLY SECTION OF EXPERIMENTAL CYLINDER.

INFLUENCE OF WAVE-FORM.

If reference be made to Fig. 3 it will be seen that No. 4 coil gives an electro-motive force whose wave-form lies between a sine curve and a rectangle. Suppose that the electro-motive-force curve of No. 4 coil were a rectangle having the same area as a sine curve about the same base line. Since the maximum ordinate of the sine curve is $\pi/2$ of the ordinate of the rectangle, it follows that the minimum induction density in the case of the rectangle will be $2/\pi$ of the average induction density. Since also with the rectangle the electro-motive force is constant for the No. 4 coil, the induction density will increase inversely as sine θ_2 (Fig. 2). The value of the intensity of magnetic induction in each of the planes α, β, γ . . . has

* Read before the Royal Society, June 12, 1902.

† See Wilson, "Roy. Soc. Proc.," vol. lxix, p. 435.

‡ I wish again to acknowledge the grant for the purpose of this research which was voted to me by the council of the Royal Society out of the government grant.

§ See "Phil. Trans.," 1885.

‖ See Barrett, Brown and Hadfield, "Inst. Elec. Eng. Journ.," vol. xxxi. part 4, pp. 681 and 703.

been calculated, and the graphical treatment described in connection with the experiments has been applied. It gives as a result 2.08 $\frac{B^2f^2l^2}{10^{16}\rho}$ for the watts per cubic centimetre dissipated by induced currents, the symbols having the definition given in the next section of this paper. The graphical treatment has also been applied when the intensity of magnetic induction is constant, and gives 3.93 $\frac{B^2f^2l^2}{10^{16}\rho}$ for the watts per cubic centimetre. This formula is in close agreement with the result of theory. We should expect, therefore, that the experimental results would give a less rate of dissipation of energy than dictated by the consideration of constant intensity of induction, and this is found to be the case. It may be mentioned that as the above graphical methods rest upon calculation, the paths of the respective curves were determined by many more points than were possible in connection with the experimental results.

THEORETICAL CONSIDERATIONS.

Let B = average induction per square centimetre in C. G. S. units.

f = frequency in complete periods per second.

ρ = specific resistance of the material of the cylinder in ohms.

$l = 2l$ = length of cylinder in centimetres along its longitudinal axis.

$2nl$ = diameter of cylinder in centimetres.

R = maximum radius of cylinder in centimetres.

x, y, z be axes as shown in Figs. 1 and 2.

In any plane section such as α, Fig. 2, one can consider three distributions of the currents induced in the cylinder by rotation in a magnetic field, the lines of force being parallel to the planes α, β, γ, . . . and at right angles to the longitudinal axis of the cylinder.

(1) There is the distribution assumed by Baily* in which the electric currents flow in rectangular paths similar to the boundary of the plane of section $\alpha\beta\gamma$ . . . . On the assumption that the rate of cutting lines of force is proportional to the distance from the centre of a plate, and that the distribution of magnetism is such that any point in the plate is cutting lines of force during two-thirds of a revolution, and that for the remaining one-third revolution the point is traveling along the lines of force, Baily has shown that, when R is great compared with t, the average rate of dissipation of energy per cubic centimetre of the plate is given in watts by the formula 3 $\frac{B^2f^2l^2}{10^{16}\rho}$. Assume that the cylinder rotates about its longitudinal axis in a truly uniform magnetic field. Assume also with Baily that the length of the path of the induced current

$$= 4z + nz \sin \theta^2 = 4z \left\{ 1 + n\frac{\sqrt{(n^2l^2 - x^2)}}{nl} \right\} \text{cms.},$$

and that the electric resistance of the path

$$= \frac{4z\rho}{dx\,dz} \left\{ \frac{1}{n} + n\frac{\sqrt{(n^2l^2 - x^2)}}{nl} \right\} \text{ohms.}$$

The electro-motive force in volts = $8z^2\pi f n B 10^{-8}$. Then the total rate of dissipation of energy in watts

$$= \frac{16\pi^2B^2f^2n^3l}{10^{16}\rho} \int_0^{nl} \frac{lx}{l + n\sqrt{(n^2 - x^2)}} \int_0^l z^3\,dz,$$

and this reduces to

$\frac{8B^2f^2l^5\pi^4}{10^{16}\rho}\left(\frac{\pi}{2} - 1\right)$, when $n = 1$;

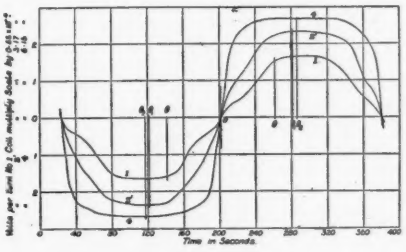


FIG. 3.

$$\frac{8B^2f^2l^5n^3\pi^2}{10^{16}\rho}\left(\frac{\pi}{2n} - \frac{1}{n\sqrt{(n^4-1)}}\log \frac{\sqrt{(n^2+1)} + \sqrt{(n^2-1)}}{\sqrt{(n^2+1)} - \sqrt{(n^2-1)}}\right),$$ when n is greater than unity;

$$\frac{8B^2f^2l^5n^3\pi^2}{10^{16}\rho}\left\{\frac{\pi}{2n} - \frac{2}{n\sqrt{(1-n^4)}}\left(\tan^{-1}\sqrt{\frac{(1-n^2)}{(1+n^2)}}\right)\right\}$$ when n is less than unity.

The average watts per cubic centimetre of the cylinder as given by the above formulæ are

$$7.16\frac{B^2f^2l^2}{10^{16}\rho} = 1.79\frac{B^2f^2l^2}{10^{16}\rho} \text{ when } n = 1.$$

$$19.7\frac{B^2f^2l^2}{10^{16}\rho} = 4.9\frac{B^2f^2l^2}{10^{16}\rho} \text{ when } n = 200.$$

When $n = \frac{1}{200}$ the value of $\frac{\pi}{2n} - \frac{2}{n\sqrt{(1-n^4)}}\left(\tan^{-1}\sqrt{\frac{1-n^2}{1+n^2}}\right)$ is very small indeed.

By modifying the expression for the resistance of the rectangular path, Mr. Dale shows that the watts per cubic centimetre = 4.69 $\frac{B^2f^2l^2}{10^{16}\rho}$ when $n = 1$, and 12.6 $\frac{B^2f^2l^2}{10^{16}\rho}$ when n is much greater than unity.

(2) There is the distribution assumed in connection with the experiments, that is, the induced currents distribute themselves on the surface of cylinders similar to and concentric with the cylinder experimented upon. Mr. Dale has dealt with this case theoretically for a uniform magnetic field, and shows that the watts per cubic centimetre of the cylinder = 3.95 $\frac{B^2f^2l^2}{10^{16}\rho}$ when $n = 1$, and 7.9 $\frac{B^2f^2l^2}{10^{16}\rho}$ when n is much greater than unity. The former co-efficient is in very good agreement with the graphical result, which is 3.93.

(3) There is the case in which the current density in any path is constant throughout the whole length of the path. Mr. Dale has also dealt with this case theoretically and shows that the watts per cubic centimetre = 4.09 $\frac{B^2f^2l^2}{10^{16}\rho}$ when $n = 1$, and 11.1 $\frac{B^2f^2l^2}{10^{16}\rho}$ when n is much greater than unity.

COMPARISON OF EXPERIMENT WITH THEORY.

In table I the formula 3.95 $\frac{B^2f^2l^2}{10^{16}\rho}$, multiplied by the volume of the half cylinder, is used, in which B is the maximum average value of the intensity of magnetic induction given by coil No. 4. It will be seen that experiment gives a lower value for the total watts in the half cylinder than the formula, and this is to be expected from the wave-form.

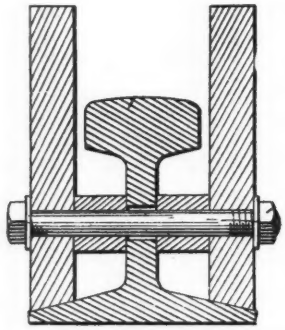
At 45 seconds periodic time and maximum average induction density for No. 4 coil 5,900, the ratio of the watts given by theory and experiment is 3.15, which is much larger than the average. The explanation is that the magnetic induction is crowded to the surface of the cylinder, and as the wave-form for this portion is more nearly rectangular, the result is to make the watts given by experiment relatively smaller. At periodic time 90 seconds we see the same influence at work when maximum average induction density given by coil 4 is 6,700. On the other hand, there is no great difference between the results at 360 and 45 seconds periodic time with approximately uniform distribution of the intensity of magnetic induction.

(*To be continued.*)

*See "Phil. Trans.," A, vol. clxxxvii (1896), pp. 715-746.

Electrical Patents

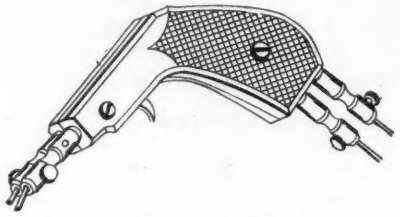
A novel guard for third rails of elevated railways has been patented by Sterling Elliott, of Boston, Mass., his object being to prevent the falling of sparks upon persons or things below the track. To this end he places upon opposite sides of the rail upright guards, which may be constructed of plank, that rest upon the lower rail flanges and extend above the head, being spaced a slight distance therefrom. These guards are held in place by bolts which pass through the rail, suitable spacing collars being interposed between the rail and guards to hold the latter in proper position. As a result, it will be seen that any sparks formed will drop between the guards and thus can not fall to the street below.



GUARD FOR THIRD-RAIL SYSTEM.

Small openings are made at suitable intervals to permit the escape of water.

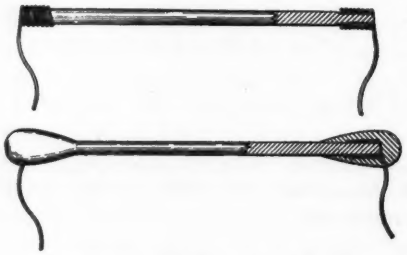
An electrical cauterizing instrument has been invented and patented by Mr. Walter B. Batcheller, of Chicago, Ill., who has sold his entire interest in the same to George G. Hunter, of Des Moines, Iowa. He employs a body which is in substantially the form of a pistol grip and comprises two mating sections detachably secured together and constructed of insulating material such as hard rubber. These sections have longitudinal grooves in their adjacent faces, forming, when the sections are placed together, conduits through which pass the conducting wires. The upper edge of the body is straight, so that an operator can hold it in the line of vision and sight over it if required to look into a person's mouth or other cavity when using the instrument. The ends are provided with suitable binding-posts connected with the conducting wires, one set of these posts being arranged to receive the cauterizing wire, battery wires being connected to the other set. One of the conducting wires leading through the body is formed in two overlapping sections, the ends of which are normally spaced apart so as to open the circuit, and a trigger is pivoted in a suitable cavity in the body, this trigger being arranged to engage one of the overlapping ends and force it into



ELECTRICAL CAUTERIZING INSTRUMENT.

engagement with the other, thereby completing the circuit. It will be apparent that the operator can readily apply the structure to the part to be operated upon and instantly close the circuit by pressing upon the trigger. In like manner, the circuit may be instantly opened by releasing such pressure.

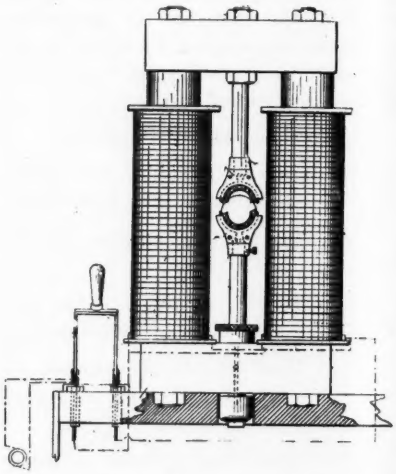
Mr. Charles P. Steinmetz, of Schenectady, N. Y., has patented an improvement in electrical lamps of the pyro-electric type in which a glower is employed that is non-conductive at ordinary temperatures, but becomes conductive when heated. These glowers are ordinarily small sticks of magnesium or other earthy metal, having fine platinum leading-in wires wrapped around their ends. It has been found, however, that after the lamp has been running a while, the contact between these wires and the stick becomes greatly impaired, the stick growing smaller where the wires are wrapped around it, so that the winding becomes loose. The improvement resides in enclosing the wire-wound ends of the stick in magnetite and then fusing. This prevents wasting away of the stick and the



GLOWER FOR PYRO-ELECTRIC LAMPS.

ends run much cooler than those of the ordinary lamp of this type. Magnetite (Fe_3O_4) has the advantage of being conductive at all temperatures, slightly so when cold, but increasing rapidly with a rise in temperature. Moreover, it can be fused to make a firm compact mass at the joint between the wire and the stick, but yet it will successfully withstand the heat at which the stick becomes incandescent. In carrying the invention into effect, the magnetite or the like in powdered form is sprinkled on the platinum wires where they are wound upon the ends of the glower. These ends are then heated for a moment, in a small electric arc between carbon points, to melt the magnetite about the wires.

An electrically operated bottle-capping machine has been patented by Mr. Louis K. Borie, of San Francisco, Cal. He employs two upright electromagnets of the solenoid type that are spaced a slight distance apart, and comprise two solid cores fitting in spools. A head connects the lower ends of the magnets and is attached to a base, upon which is



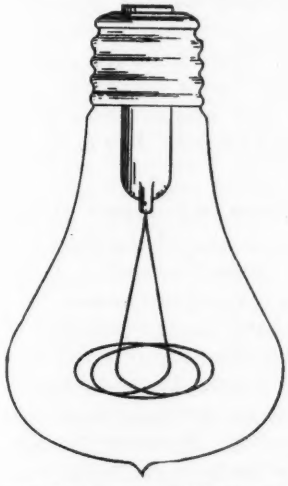
ELECTROMAGNETIC CAPPING MACHINE.

mounted a suitable switch controlling the current to the magnets. The upper ends of the movable cores are connected by an upper head that is thus movable toward and from the lower one. These two heads carry, respectively, upstanding and depending arms that are arranged between the electromagnets and have jaws on their adjacent ends, which jaws are set in opposition to each other, and are properly shaped to embrace and crimp the bottle caps. The lower arm is adjustably mounted so that it can be removed toward and from the lower one. These two heads can be adjusted to act with varying degrees of pressure and on different sizes of bottles.

Mr. W. N. Gove, of Philadelphia, Pa., has recently been granted a patent for an improved gravity battery, such as are used to operate four-ohm resistance telegraphic sounders, and for other purposes. The improvement consisting of an amalgamation of three different kinds of metal which is substituted for the copper ele-

ment now in use in these batteries; the new electrode seemingly making a better conductor of electricity and the electromotive force being greater than the copper cell, probably because of the amalgamation of these metals. Instead of it being necessary to use two cells for the above mentioned purpose, it is claimed by this inventor that only one cell is necessary when the battery is constructed with the amalgamated metal, thus the saving in metal being about one half. The new combination metal is also cheaper than copper, and can be used in other batteries where the last named metal is one of the elements.

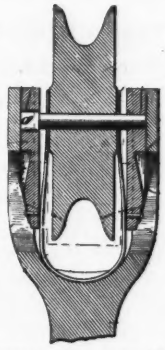
The Shelby Electric Company, of Shelby, Ohio, controls a patent recently issued to Mr. Adolphe A. Chaillet, a Frenchman residing in Shelby, Ohio. The inventor's idea, practically stated,



IMPROVED INCANDESCENT ELECTRIC LAMP.

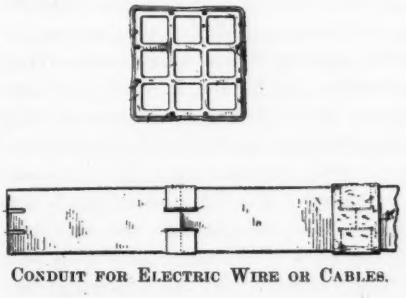
is to flatten the coil, and also flatten the end of the globe or bulb so that the greatest intensity of light shall be thrown downwardly. The filament is coiled in a form which presents a loop that is elongated transversely of the axis of the lamp, or in other words, the loops are substantially elliptical, the major axes being transverse to the longitudinal axis of the lamp. The globe is likewise flattened at its tip end so that the glass wall is substantially parallel with the lower lines of the filament loops when the lamp suspended from above.

Mr. George H. Russel, a citizen of Pittsfield, Mass., has just patented improvements in overhead trolleys. The bifurcated portions of the harp have aligned openings and are also provided with dove-tailed grooves in their opposing inner faces. In these grooves are slidably mounted journal blocks normally held against displacement by flat metal springs carried by the blocks and engaging in the aforesaid openings. The axle for the wheel is fastened to these blocks and extends across the space between them, being held against rotation by a



OVERHEAD TROLLEY DEVICE.

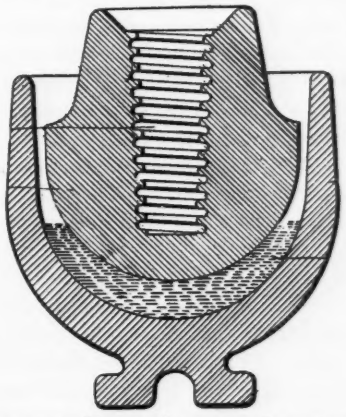
square head fitting in a similar opening in one. The wheel, which is of the usual shape, rotates upon the shaft, and is narrower than the distance between the blocks, so as to accommodate itself to any unevenness in the trolley wire. In order to hold it centered, however, a U-shaped spring is employed, the ends of which straddle or embrace the wheel, being provided with openings through which the axle passes. The bowed portion of this spring is seated in the lower end of the bifurcation, and is thus held against accidental displacement. As a result, the wheel can move a slight distance in either direction upon the shaft, but it is brought back to central position by the spring when the lateral pressure has been removed. To remove the trolley wheel from the harp, it is only necessary to press the holding springs inwardly, thus releasing the blocks, which can then be slid out of the upper end of the harp.



CONDUIT FOR ELECTRIC WIRE OR CABLES.

Mr. R. W. Lyle, a citizen of Perth Amboy, N. J., has invented an improvement in electric conduits, wherein the usual centering dowels or pins are done away with. The sections or titles are constructed in substantially the usual form, being provided with a plurality of vertical and horizontal webs or partitions, forming a plurality of separate longitudinal passages. In the exterior faces of the tiles or sections, are arranged grooves which are located in line with and directly opposite the webs or partitions so as not to unduly weaken the structure. These grooves extend to the end of the tile, so that when several are arranged end to end, the grooves will be aligned. In order to fasten the several tiles or sections together, corner clips are employed, made of suitable yielding material and comprising arms which are disposed at an angle to each other. The terminals of these arms are bent inwardly to form hooks. These clips engage about the corners of the abutting ends of the tiles and the hooks engage in the longitudinal grooves. As a result, the tiles will be securely locked in true alignment, and, as the clips almost entirely cover the joints, the conduit will be protected and foreign matter will be excluded.

Mr. Fred M. Locke, of Victor, N. Y.,



PROCESS OF MAKING IMPROVED INSULATOR.

has devised a new process of making insulators. He constructs these devices of two parts; an outer shell which is arranged to fit over an inner head, the latter having a screw-threaded socket for the reception of the supporting pin. The sections are constructed separately and are dried in the ordinary manner, after which they are dipped in liquid glaze, the outer shell being drawn from the same bottom-side upward, so that a small quantity of the glaze remains in the bottom. The head is then fitted within the outer shell and the insulator is placed in the kiln for firing. It is a well-known fact that the glazing material fuses at a much lower temperature than the porcelain, and therefore, as the sections begin to shrink and contract, the inner head sinks down into the outer shell and forces the glaze which has been left in the bottom thereof upward, thus cementing the sections together so as to form practically but a single piece.

Reviews of Current Engineering and Scientific Literature.

Giving Concisely the Substance of Important Papers in the Scientific, Electrical and Engineering Press of the World.

Surges in Transmission Circuits.

This subject has been previously discussed by Steinmetz and Kennelly, but in a mathematical manner. This paper by F. G. Baum takes up the subject in a very simple way, so that any one with an elementary knowledge of alternating currents can easily follow it. Three cases are discussed—First, opening a line under a load or short-circuit; second, closing a high-potential switch to charge the line; third, opening a high-potential switch to deaden the line. Opening a line under a load or short-circuit: This line is considered with the receiver load concentrated at the end. The capacity is assumed equivalent to a single capacity at the centre of the line. The energy stored up in the magnetic field must, when the circuit is broken, flow into the line condenser, since there is no other outlet. Thus, the condenser assumes the same amount of energy, less the small loss due to the line resistance which previously existed in the field. What happens when the current is interrupted is this: The line discharges into the condensers. The condenser then discharges into the line and the energy is again in the form of magnetic energy. This process is repeated until the resistance of the line consumes the energy originally stored in the line as self-induction. An instance is taken with a natural frequency of 200. The voltage in this case is then approximately, $V = 200\ I$. The maximum strain will be: $E\sqrt{2} + 200\ I\sqrt{2}$ E being the impressed voltage. On long lines we usually have loads distributed along the entire line, and a portion of the line energy discharges into the local distributing circuits with less strain to the system. The amount of energy stored in one-half of a 100-mile line is quite small. For 200 amperes it is 1,600 joules—that is, 1,600 watts for one second. Closing a high-potential line switch: In first closing a line switch on a dead line a current will flow into the line condenser, but this current to reach the condenser must flow over the self-induction and energy will be stored in the magnetic field. This energy will then discharge into the condenser and add to the charge already in it. The maximum rise in potential is double normal working value. Opening a line switch: If we open a line switch to deaden a line, we have the condenser of the line discharging at the periodicity of the line across the switch terminals the moment they are separated. Due to the charging current of the condenser, the potential of the line rises to its maximum working value at normal frequency of the circuit. The maximum possible rise in potential in this case is double normal working value. We see from the above that the most dangerous condition is brought about when we suddenly open a short-circuit. If we continue to lengthen our lines until the natural periodicity of the circuit becomes nearly equal to the impressed periodicity, it is very probable we will have some new problems to solve. It may be that this will prove the determining factor which will limit the distance of transmission.—*The Journal of Electricity, Power and Gas* (San Francisco), June.

What Sag Shall Be Given to Bare Free Conductors of Soft Copper?

The principal data in this subject have been given by Herzog, but these leave much to be desired, as he has not allowed sufficiently for the effect of weather. Practice has taught that his tables always give too small a sag. If the wire is suspended in free air without a load, specific tension for a cross-section of sixteen square millimetres is given as four kilogrammes. This approaches the highest allowable for soft copper. When a load of three-tenths of a kilogramme per metre in length is added, the tension becomes eight and one-half kilogrammes. For this reason these tables are not used in practice, but this important work of stringing the wire is left to the wiremen. In the following discussion Herzog's formulæ and values are made use of. A load due to snow is of little importance, for a sharp wind will clear it off. It is otherwise with ice. The author calculates the maximum load due to ice as ten per cent of the weight of the wire for solid conductors and fifteen per cent for stranded conductors. Wind pressure is then considered, but as this acts at right angles to the force due to ice, the resultant of the two must be determined. This is done graphically and results given in a table showing the allowable sag for different cross-section and various lengths of span. This table, however, can not be used at once, for as the wires are strung in still air it must be corrected for load and temperature. This is done and the results are given in a series of curves. When wires of a different cross-section are strung together, the sag for the weakest is used. When they are strung in places protected from the wind, a smaller sag is allowable. On seacoast a greater sag must be given. These tables give figures which are better than a rough guess, and are thought to be valuable.—*Electrotechnische Zeitschrift* (Berlin), July 3.

Some Notes on Polyphase Machinery.

In this section of the serial by A. C. Eborall, alternating-current motors are taken up. The synchronous motor is first discussed and its characteristics described. It must be brought up to full speed and suitably excited. The power-factor of the motor can be varied at will by changing the excitation. By overexciting the motor it can be made to operate with a heavy leading current. The efficiency of the motor is high over a wide range of load. An auxiliary starting motor must be provided. Formerly synchronous motors were sometimes arranged to be self-starting by throwing them upon the line through auto-transformers. As synchronous motors are invariably of medium or large size, such a method of starting is objectionable, and for this reason is hardly ever used. In regard to the ability of changing the power-factor, the synchronous motor is of the greatest value, for it means that the system from which the motor is operated can be maintained at a high power-factor throughout. Lagging current caused by asynchronous motors, arc lamps, etc., can be mostly balanced out by the leading currents, taken by a few synchronous motors distributed over the system. The pressure drop on a long transmission line can be compensated for. When synchronous motors are used as boosters or compensa-

tors, they must be built larger than would otherwise be necessary. The speed of the motor varies in the same proportion as that of the generators in the power station, not only in regard to the actual number of revolutions made in a given time, but also in regard to the speed variation in revolution itself. Consequently it is of the first importance that the speed regulation of the prime movers driving the generators should be as close as possible, or hunting of the synchronous motors may be set up. In this connection dampers on the field-poles of synchronous motors are of considerable assistance. The properties of polyphase synchronous motors are well illustrated by test curves, and full data of a typical motor are given. The natural field of application of such synchronous polyphase motors is clearly that in which constant speed, maximum power-factor and perhaps leading currents are of importance, and where a starting torque and the cost of special starting arrangements are of little importance. For large substation work such motors are excellent, being much superior to the corresponding sizes of asynchronous motors. The advantages of the asynchronous or induction motors are next discussed. In regard to the starting capabilities of induction motors used for every-day industrial purposes, there is still a certain amount of misunderstanding among engineers. Induction motors with permanent short-circuited rotors require abnormal starting current, especially if they are required to start against any considerable load. For these reasons the very best induction motors of this type on the market take a current equal to at least twice the full-load current in starting against the load offered by belt and loose pulley only. When starting with a full-load torque this will increase to three or four times the load current. The successful operation of a large power distribution system would be impossible with large motors of this type used indiscriminately. In the author's opinion, all motors below five brake horse-power having to start against load should be fitted with slip rings and a starting resistance. A table is given illustrating the starting of the typical modern three-phase motor with slip rings and of standard design. For a starting current equal to the full-load current, the torque at starting current is about ninety-seven per cent of the full-load running torque. Moreover, the maximum starting torque is equal to two and one-half times the full-load running torque. The table also gives a good idea of the running performance of standard three-phase induction motors. The advantages of low frequency with slow-speed motors is discussed and the performance of the motor illustrated by curves.—*Engineering* (London), June 27.

High-Tension Continuous-Current Systems.

The object of this paper is to show that those engineers who have pinned their faith to a continuous-current plant are able to offer a reliable alternative to the three-phase generator and transformer. As far back as the year 1890 direct-current generators and transformers working at a pressure of 1,000 volts were installed at the Crystal Palace. The next important step in the use of high-tension current appears to have been in the municipal station at Walsall, where it was combined with direct-coupled high-speed generators working at a pressure of 2,000 volts. The continuous-current generator is less expensive than a three-phase alternator. When we consider the transformers, the continuous-current appears to have a decided advantage over the polyphase plant. A transformation from 3,000 to 220 volts on the continuous-current system is effected by one machine. On the three-phase system there is in addition to the motor-generator a static transformer, and the two occupy more space and represent more capital outlay than does one rotary transformer of the continuous-current system. The attention required at the continuous-current substation is less than that required at a three-phase substation with motor-generators. The transformers are started and stopped and entirely controlled by an attendant at the central switchboard, and there is therefore no need for an attendant at the substation to manipulate the switch gear. Another advantage of the continuous-current transformer is that there is no phase difference between electro-motive force and the current, and consequently no excess of current is demanded at light loads, as is the case with the polyphase converters, and there is no possibility of the transformer hunting. It is pointed out that in the high-tension continuous-current system the momentum of the moving parts is a very important advantage, a sudden fluctuation of load on the low-tension side causing the machine to act as a generator. The momentum of the armature of a rotary converter tends to throw the machine out of step. In starting up a continuous-current transformer there is no difficulty with regard to the polarity on the low-tension side, as is the case with the polyphase converters when these are not started from the continuous-current side. The efficiency of the continuous-current transformer is not so high as that of a three-phase rotary converter, but the polyphase system generally employs a static transformer in addition, and the combined efficiency of the two is only ninety per cent, while that of the continuous-current transformer is as high as ninety-two per cent. A comparison of the cost of rotary transformers for continuous, and motor-generators for three-phase currents, shows a similar result to that of the generators. An interesting part of the high-tension continuous-current work is the switch gear employed at the generating station and substations. With a carefully designed flare-switch, where the arc is allowed to die away gradually, no difficulty is experienced due to the discharge of the line. Indeed, there are advantages in the high-tension switches, owing to the proportionately smaller current to be carried and the smaller risk of heating due to bad contacts. The efficiency of circuit and transformation is given for two cases as 87.8 per cent and 86.3 per cent, respectively. —*Electrician* (London), July 4.

The Atmosphere and Radio-Active Substances.

The experiments of Elster and Geitel and of Rutherford have shown that a negatively charged body exposed in the atmosphere becomes radio-active, apparently showing the presence of some radio-active substance in the atmosphere. Freshly fallen rain-water (less than 50 c.c. being generally used) has been found in recent experiments by Mr. C. T. R. Wilson, when evaporated to dryness to leave behind a radio-active residue. The radio-activity was detected by means of the increase in the ionization of the air within a small vessel, of which the top, or, in other experiments, the bottom was of thin aluminum or of gold-leaf, the other walls being of brass. The metal surface on which the rain had been evaporated was placed close up to the aluminum or gold-leaf, and the rate of movement of a small gold-leaf which served to measure the ionization was observed. In many cases the radio-activity obtained from the rain was sufficient to increase the ionization five or sixfold. From the evaporation of distilled water, of tap-water or of rain-water which had stood for many hours no radio-activity was obtained. Like the induced radio-activity obtained on a negatively charged body, that derived from rain gradually dies away, falling to about half its initial value in the course of an hour.—*Nature* (London).

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Motor-Driven Tools.

Any attempt to detail the importance, or to record the application, of the electric motor to the direct driving of machine tools would show that in a comparatively short space of time an almost undreamed of demand has been built up, and the most prominent manufacturers of the country are exerting every effort to produce motors which shall have above all the peculiar advantage of being applicable for this phase of the distribution of power.

The accompanying illustrations will be of great interest to workers in iron and steel and all other users of machine tools. They show the application of a standard

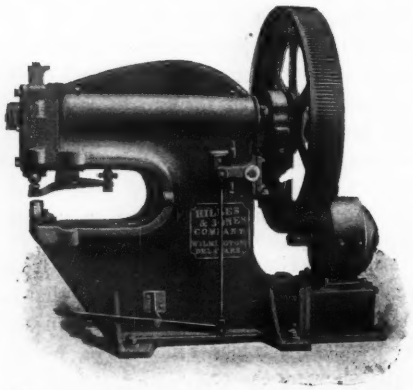


FIG. 1.—MOTOR DIRECT-COUPLED TO RAPID-ACTION PUNCH.

motor to difficult conditions of service, but form only a very small part of a long list of applications which are giving great satisfaction and economy in machine-shop operation.

To meet the demand for a protected form of motor, the machine shown in the accompanying illustrations is the result of a careful study along the lines laid down by the requirements of the most practical and efficient shop service. The type "I" machine is made in two forms—a semi-enclosed and fully enclosed. The latter differs from the first only by the addition of hand-hole covers which fit tightly over the openings in the end shields. The opportunity for cooling is thus greatly reduced, since the only radiation possible has to be obtained directly through the frame of the motors. For this reason the fully enclosed type is rated considerably lower than the semi-enclosed machine. The general design of the machine consists of a circular cast-iron ring flanged inwardly at both ends. These flanges are carefully machined to permit of close attachment being made with the end shields, these plates being secured by four machine screws accurately placed. By this means the shields may be revolved one-quarter or one-half a revolution, retaining the oil wells beneath the shaft if it is desired to mount the motor on a wall or inverted, a simple method of changing from one position to the other requiring but the changing of eight screws. The motor is equally adaptable with the type "F" machine for belted or geared connection to machine tools. The ratings range from three to forty-five horse-power, each size being designed for slow and moderate speeds, which gives an additional rating in each case. The firm attachment of the end-plates to the frame of the ma-

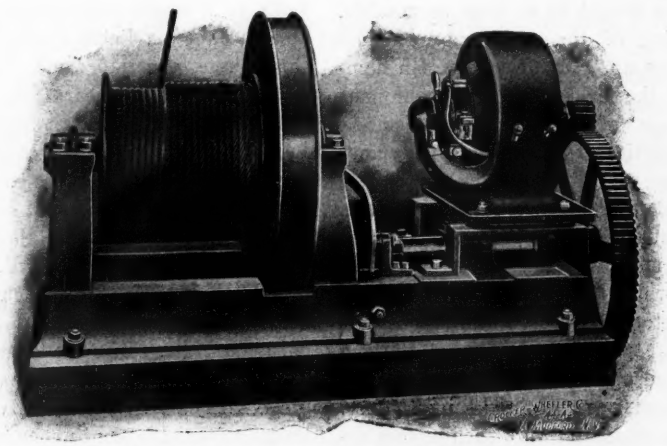


FIG. 2.—MOTOR DRIVING COUNTERSHAFT OF SPECIAL TYPE OF DRUM HOIST.

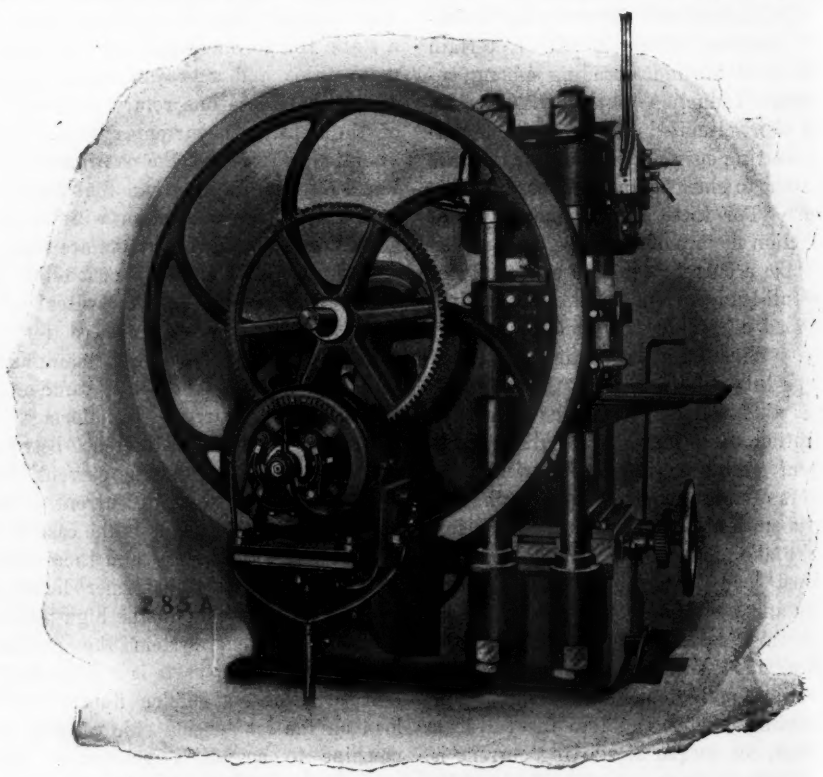


FIG. 3.—MOTOR COUPLED TO FLYWHEEL OF HEAVY EMBOSSING MACHINE.

chine means a very secure alignment of the shaft, hence the bearings, which are of brass, are supported solidly within suitable openings in the end-plates. Cast-iron feet projecting from the frame afford a means of attaching the motor to a rail base or directly to the frame of the machine the motor is to operate. When speed reduction is required at the motor, this is accomplished with a countershaft whose bearings are cast as a part of the motor frame at one side and near the base. A very rigid support is thus given, enabling the motors to stand the heavy strains which are often imposed by such gearing. Reduction ratios as high as eight to one can be given with this single countershaft, which is as high as is usually desired with a single reduction. Fig. 1 shows a semi-enclosed type "I" motor geared to the flywheel of a rapid action punch.

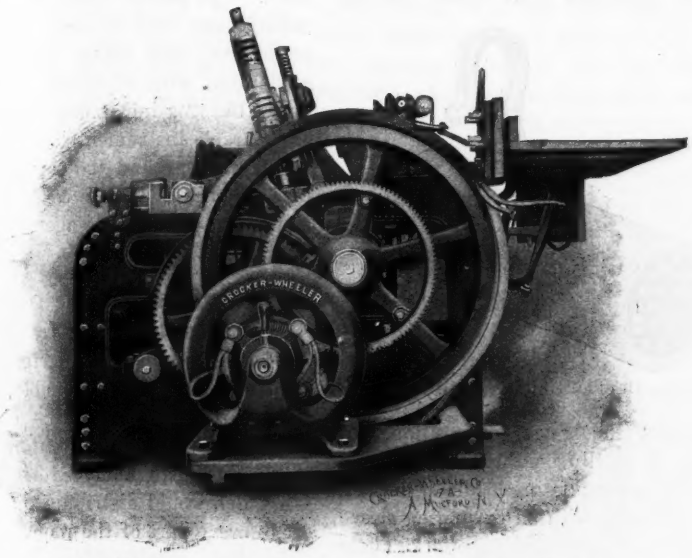


FIG. 4.—MOTOR ATTACHED TO ROUNDING AND BACKING MACHINE.

The type "F" machine was put on the market a few years ago to provide a small, compact multipolar motor of open construction to run under continuous, or nearly continuous, full load. The openings are sufficiently large to permit the free passage of air currents to all moving parts and of easy access to the commutator brushes and bearings, but the shape of the frame is such as to render good protection to the fields and armature against any ordinary interference. This machine is designed in outputs ranging from three to nine horse-power, each size being built for both slow and moderate speeds. The cast-iron magnet frame is circular in form, with an external flange made in one piece and embodying one bearing as well. A pedestal for the other bearing is split to afford a means for removing the armature. The feet are cast as a part of the frame and project just far enough to give room for bolt holes for the attachment of the motor. If the motor is to be belted, a rail base is supplied to furnish the means for tightening the belt; otherwise the motor is bolted fast to the machine to which it is geared. There are four wrought-iron fields cast into the frame and provided with a separate laminated pole-face to prevent the heating effect from the formation of eddy currents.

The armature is built up of sheet-iron stampings keyed to the shaft and with ample ventilations running lengthwise. The commutator is made of the best grade of copper, and the utmost care is used in its construction to ensure a proper commutation of the current and long life. The motors are wound either shunt, series or compound, depending on the service in which they are to be used. The series winding is particularly well adapted to hoisting purposes. A type "F" motor driving a special type of drum hoist with double reduction gears is shown in Fig. 2. The shunt is a constant-speed motor, and the compound fills any position where the motor must be started under load.

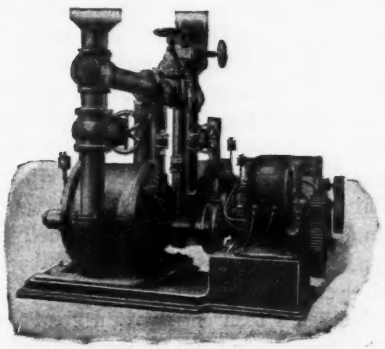


FIG. 5.—MOTOR DRIVING SIDE SHAFT OF PRESSURE BLOWER.

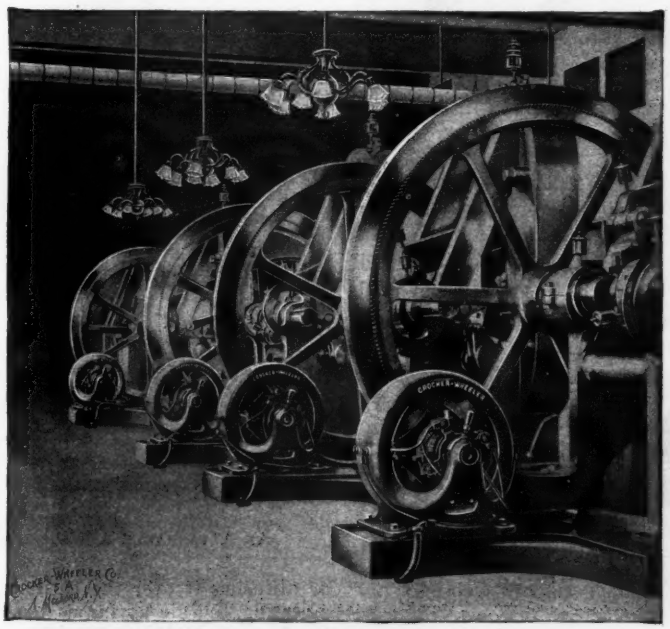


FIG. 6.—GROUP OF STAMPING PRESSES, INDIVIDUALLY DRIVEN BY ELECTRIC MOTORS, UNITED STATES MINT, PHILADELPHIA, PA.

Fig. 3 shows a type "F" motor geared to the flywheel of an embossing press. This service is one of peculiar requirements in that the motor runs under light load for a considerable period of the revolution of the machine, the load very rapidly rising to a maximum and then as rapidly falling away as the stamping pressure is released.

Fig. 4 shows the application of a type "F" motor mounted on an extended base

and geared to the flywheel of a rounding and backing machine. This is a machine which is widely used in almost every bookbinding establishment of any prominence, and is probably one of the most serviceable applications of small motors to this industry.

Fig. 5 shows a type "F" motor with a side countershaft coupled to a pressure-blower.

In the application of motors to machine-tool driving, the space allotted to the motor is very frequently so limited that the question of design becomes one of great importance. The compactness of this machine, and particularly its short length of shaft, allows it to be very closely applied, and it economizes space in a very satisfactory manner. These machines are made by the Crocker-Wheeler Company, of Ampere, N. J. The manufacturer has made a careful study of the application of motors to the direct and belted driving of machine tools, and originates and designs many forms of apparatus where for a long time it was conceded impossible to install a successful electrical unit. A noteworthy installation of these machines is at the United States Mint, in Philadelphia. Fig. 6 shows a group of stamping presses driven individually by type "F" motors. In this mint the use of electric power for the operation of machinery has been carried to a greater extent than in any other similar installation. Practically all of the machines employed in the coinage operations are driven by individual motors arranged especially for geared connection, making a compact and workmanlike equipment.

Telephone and Telegraph Material.

The accompanying illustrations show some of the latest productions in telephone and telegraph construction material for outside use. Fig. 1 is the Villard double grip cable-hanger. This is suitable for any size cable. It is made very strongly and grips the cable firmly. The hook and grip are of one piece, of galvanized steel wire. The hook, once placed, stands erect while the cable is being drawn along the messenger wire to its resting-place, making the messenger wire at any time easy to hook. While the strap is drawn closely around the cable and is held with great firmness, the grip does not in any way injure the cable by embedding the strap therein.

The hanger is held in the left hand, with the strap resting against the cable and the hook turned back. The free end of the strap is passed under the cable and through the grip, holding it up as far as it will go, and the hook is then held in an upright position. The raising up of the hook causes the grip to draw on both ends of the strap at the same time from the two opposite directions, thus firmly binding

FIG. 1.—DOUBLE GRIP CABLE-HANGER.

and locking the hanger in position, not allowing it to slip on the cable. Fig. 2 shows the new insulating bridle or distributing ring used with an expanding sleeve for fastening in brick or stonework. These bridles or distributing rings are made

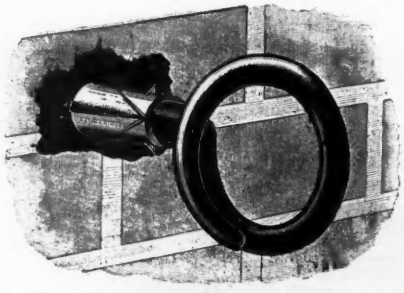


FIG. 2.—INSULATING BRIDLE OR DISTRIBUTING RING.

of the best quality of iron, heavily coated with tough glass enamel. They are readily screwed in by the hand into the most difficult and out-of-the-way places, and when desired can be unscrewed and used in other places indefinitely. The wires

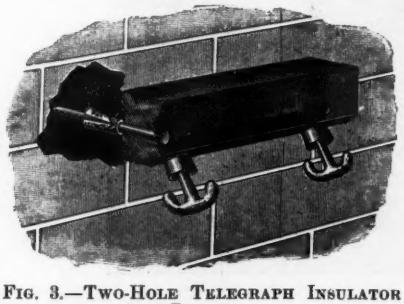


FIG. 3.—TWO-HOLE TELEGRAPH INSULATOR BLOCK.

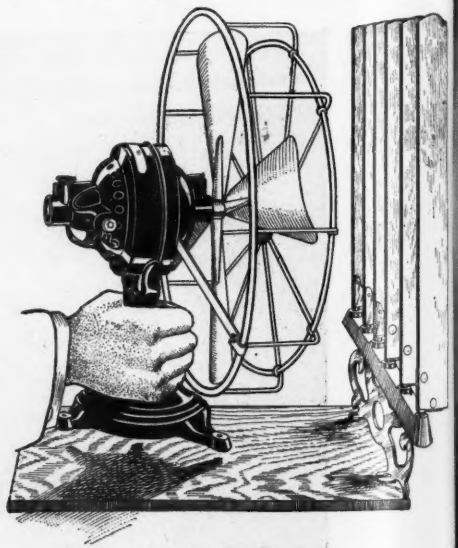
are easily inserted and removed at the opening on the side without injury of any kind, and the glass enamel coating prevents the rusting of the rings.

Fig. 3 is a two-hole telegraph or rubber hook insulator block. This is made of well seasoned wood and is heavily coated with oil paint. This illustration also shows the use of the patent expanding sleeve for attachment to brick or stonework. The patent insulated bridle is advantageously used on corner work with an angle iron, this being riveted into the angle iron with a square shank, which makes twisting impossible, forming a neat and durable instrument for carrying telegraph wires around the corners of buildings. James S. Barron & Company, New York city, are the sole agents and manufacturers of these devices.

An Attachable Air Diffuser.

A straight blast of air from an electric fan is deemed in some quarters to be in a slight measure objectionable, and, although the weight of this objection is greatly exaggerated, inventors have recently put forth many efforts to build a fan which would distribute the current of air to every part of the room.

In the accompanying illustration is shown a device which has been lately put upon the market to remedy this feature, and the manufacturers claim that while in no way lessening the power of the fan in projecting its current of air, it solves the problem of the necessary circulation, spreading the current over a wider space,



AN ATTACHABLE AIR DIFFUSER.

or diffusing it over the entire room and agitating the air as far as the power of the fan may be able to send it; or concentrating the current to any point which may be desired by simply turning the diffuser blades. This diffuser may be attached to any fan. It is neat in appearance and is claimed to be simple and effective. Messrs. Degge & Musick, St. Louis, Mo., are the manufacturers of this apparatus.

Self-Contained Ignition Engine.

In the accompanying illustration is shown the gasoline and gas-ignition engine, for stationary and portable use, manufactured by the Hardy Motor Works, of Port Huron, Mich. This is built for either one and one-quarter or four horse-power capacity, and the company claims will be found to embrace a refinement and neatness of design, as well as being very reliable and satisfactory for a wide range of service. With the one and one-quarter horse-power engine a separate water or gasoline reservoir is not used, about two gallons of water being contained in the sub-base and circulated in a water-tight space by means of a piston pump. The gasoline reservoir is also in the sub-base and has a capacity of about a gallon and a half, sufficient for a ten hours' run at full capacity of the engine.

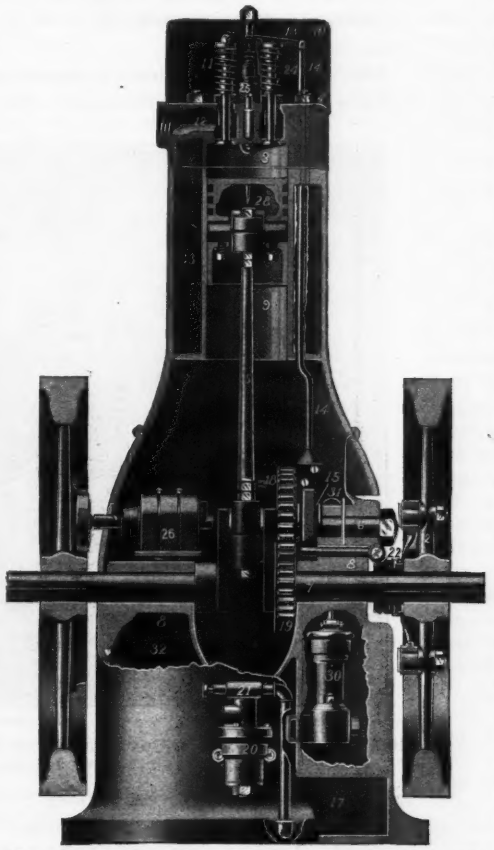
With the four-horse-power engine a small separate water reservoir, of a capacity of approximately ten gallons, is used. This water is also circulated by a piston pump. Sufficient gasoline is also placed in the sub-base for the day's run, the same as with the one and one-quarter horse-power size. With the four-horse-power engine, a separate gasoline reservoir is furnished if desired.

For igniting the charge in these engines, a magneto electric generator is used, attached to the base of the engine. The battery for charging the same is also supplied by this company. The cooling water in this engine does not become hot, as the system of cooling never allows the heat generator to lower the highest efficiency of the engine. When the engine is stopped, the water in the cylinder jacket returns to the water reservoir in the base, so that in case of freezing, the cylinder walls will not be injured.

The working parts of this engine are practically enclosed, so that it is especially desirable for use in dusty places, as in grain cleaning or elevating machinery, or for machine shop work where there is danger to the works from flying particles. The cap may be readily removed from the top of the chamber, or the door slipped out from the side of the engine, so that the entire machine can be taken apart in a few minutes if desired.

The engine is a four-cycle or four-stroke machine. The first, or induction, stroke, draws in the mixture of air and gas. The next stroke of the piston toward the cylinder head is the compression stroke. The third stroke is when ignition and expansion take place. The fourth stroke is when the piston returns toward the head of the cylinder and the burned gases are pushed out through the exhaust.

Referring to the illustration: 1 is the balance wheel on the magneto side, rigidly keyed on, at the same time being easily removed; 2, the balance wheel on the governor side; 3, the combustion chamber, which has no projections which will become overheated, thereby firing the explosive mixture at the wrong time and causing the engine to pound, and the head is water-jacketed so as to prevent



SELF-CONTAINED GAS OR GASOLINE SPARK IGNITION ENGINE, SHOWING DETAIL OF PARTS.

overheating; 4 is the combustion chamber stud, a sufficient number of which are used so that the packing will not easily blow out; 5, the connecting rod, made of malleable iron with adjustable bronze sleeves at each end; 6, the counter-shaft for pumping exhaust valve rod; 7, the crank-shaft, made of hammered steel forging slotted for the rod.

The crank shaft bearing, of ample width and provided with bronze sleeve in halves, is shown at 8, and 9 is the cylinder, which is made from ninety-six per cent pig iron and four per cent machinery scrap. A test bar of this iron, one inch section, four inches long, supports in the centre 2,800 pounds at breaking point. The cylinder cap is shown at 10. This is made of brass, and adds a finished appearance to the construction of the machine. The exhaust valve is shown at 11. This is vertical, reducing the wear to a minimum. The valve always comes to its seat in a straight line. The exhaust outlet is shown at 12; 13 is the exhaust valve arm; 14, the exhaust valve rod, and 15 is the exhaust valve cam. This cam makes a noiseless, even movement for opening the exhaust valve. The exhaust valve roller is shown at 16. This is placed on the end of the exhaust valve rod to prevent friction and side motion. The gasoline reservoir, in cast-iron base, is shown at 17; 18 is the gear on counter-shaft; 19, the crank-shaft gearing; 20, the generator and gasoline or air mixer; 21, the generator valve for regulating gasoline and air mixture.

The governor, of the ball type, having only two movements, and in a straight line, is shown at 22, and 23 is the governor speed adjustment, 24 being the inlet valve, which opens only when the governor allows the exhaust valve to close. This valve is lopped during idle strokes. Part of the igniter is shown at 25, and 26 is the magneto generator for making the spark. This is regularly placed outside of the machine.

The magneto friction wheel, which operates by contact with the balance-wheel, is shown at 27, 28 being the piston, which is provided with three spring rings; 29 showing the piston rings and 30 the pump for forcing water to cylinder and combustion chamber. An overflow from this space forms a drain, so that all water returns to the reservoir after the engine is stopped. The pump eccentric strap is shown at 31, and 32 is the water reservoir, 33 being the water space around the cylinder.

An Electric Typewriter.

An ingenious typewriter of American invention will shortly be on exhibition at the Crystal Palace, London. It is worked entirely by electricity. For instance, the bringing back of the paper roll at the end of every line, which in the ordinary typewriter has to be done by hand and necessitates a distinct movement, is done automatically by the slight pressing of a button on the keyboard. The inventors claim for the machine that it works fifty per cent faster than the present typewriters in use, and reduces fatigue to a minimum, since by the slightest touch the letters fly to the paper, whereas the ordinary typewriter requires a decided thump, which at the end of the day amounts to a great expenditure of physical force.

Second Annual Convention of the Electrical Contractors' Association of the United States.

At 10 A. M., July 16, a meeting of the board of directors of the association was called in the hall of Franklin Institute, Philadelphia. The convention, held at the same place, was not called to order until 3 P. M., awaiting the arrival of delegates on the special train sent out from Jersey City by the Jersey Central Railroad. The meeting of both the board of directors and the regular convention was as usual held behind closed doors.

The gathering of delegates, guests and electrical supply men at the Hotel Walton was a very jovial and representative one. Among those noticed were: A. Atwater Kent, A. E. Newton, of the Cutter Company; E. P. Granger, Sterling Electrical Manufacturing Company; H. F. Sandville, representing Albert and J. M. Anderson; John Dale, of the Dale Company; H. C. Roberts, Roberts Electrical Supply Company; Charles Crofut, representing Pass & Seymour; C. K. Hill, Pittsburg; Robert T. Lozier, of the Bullock Electric Company; James Olsen, of the Habirshaw Wire Company; H. B. Coho, of the Electric Storage Battery Company; Calvin B. Roulet, of the Osburn Flexible Conduit Company; Thomas L. Townsend, Vallee Brothers' Electrical Company; E. M. Lawton, Lawton Electric Company; W. H. Morton, of Johnson & Morton; F. J. Jones, of the Jones Electric Company; J. B. Snyder, J. B. Snyder Electric and Supply Company, and others.

At 4.15 P. M. the convention adjourned for a trip to Cramp's shipyard and down as far as League Island, returning to Washington Park at 6.30, where an elaborate dinner was served to delegates and invited guests.

The next day a special train over the Pennsylvania road took delegates and guests to Atlantic City, where the meeting was again called to order on the Steel Pier about 2.30 P. M., adjourning at about 4.30.

One of the topics discussed at the meetings was a method of increasing the strength and influence of the association and raising the standard of the membership.

Officers were elected as follows: President, Charles L. Eidlitz, of New York; first vice-president, G. M. Jones, of Minneapolis; second vice-president, E. T. Cook, of St. Louis; third vice-president, H. K. McKay, of Baltimore; secretary, W. H. Morton, of Utica; treasurer, George R. Mathieu, of Pittsburg.

The reception committee was composed of the following-named gentlemen: J. F. Buchanan, Henry d'Olier, Jr., William L. d'Olier, S. A. Jellett, Edwin R. Keller, H. G. Kepler, Alfred A. Lowry, H. A. Loeb, Frank E. McIntire, Walter C. McIntire, M. R. Muckle, Jr., Clayton W. Pike, T. Carpenter Smith, Gilbert S. Smith, I. C. Walker and R. C. Williams.

Death of John W. Mackay.

Mr. John W. Mackay, the well-known American capitalist and president of the Commercial Cable Company, died on the evening of July 20, at his London residence, Carlton House Terrace. Mr. Mackay was taken ill during a visit to London on July 15, and, despite the efforts of his physicians, gradually sank into unconsciousness and died the following Sunday evening. Mr. Mackay's sudden sickness on Tuesday came as he was dining with Mr. G. G. Ward, of the Commercial Cable Company. Mr. Mackay was in London to complete arrangements for a direct cable to the Philippines.

Finding himself unable to obtain a definite reply from the government about the soundings, and being unable longer to hold options on the cable manufacturers' plants, he closed a contract which provides for the completing of the line between the United States and the Philippines by June 1, 1903, provided the Navy Department will permit the use of its soundings. This was the last important official act of Mr. Mackay's life.

Mr. Mackay was born in Dublin on November 28, 1831. His life had been one of peculiar experience, having worked his way to eminence and power against the most adverse circumstances. He was the last of the four bonanza kings of the Sierra Nevada. Probably no man who has attained such prominence as Mr. Mackay has been so universally admired and beloved. His was a generous hand, and he seemed to have the greatest pleasure in bestowing liberally instant help upon those who might stand in need. It was in 1884 that Mr. Mackay went into the cable-telegraph business, and the projected new cable to the Philippines occupied his attention in his last days. His fortune ten years ago was estimated at $45,000,000, and has probably doubled since that time. Congestion of the lungs and brain is given as the cause of death.

An informal meeting of Americans sojourning in London, held in the Carlton Hotel, adopted resolutions expressing regret at the death of John W. Mackay and tendering sympathy to Mrs. Mackay and the other members of the family.

The accompanying group photograph was taken on board the cable steamship Mackay-Bennett, in New York Harbor, in 1900. This is supposed to be the latest photograph that has been taken of Mr. Mackay. With him on this occasion were several of the officials of his company and several prominent officials of foreign cable companies.

GROUP OF CABLE OFFICIALS ON CABLE SHIP MACKAY-BENNETT. THE LATE JOHN W. MACKAY SEATED IN FRONT ROW, THE SECOND FROM RIGHT OF PHOTOGRAPH.

The buildings and offices of the Commercial Cable and Postal Telegraph companies have been draped in mourning throughout the country.

Another Marconi Achievement.

Cable messages to the New York press state that William Marconi has received messages from Poldhu, a station on the Cornwall coast, at Cape Skagen, and signals at Cronstadt. The distances are, respectively, 850 and 1,400 miles from Poldhu, crossing England at its widest point and through a part of Denmark. It is understood that the inventor's new magnetic receivers were used, and these have been found to give greater satisfaction than anything tried before. Mr. Marconi has been signally honored in connection with King Victor Emmanuel's visit to the Czar, and it is understood that he was presented personally to the Czar by the King on the Italian flagship Carlos Albert.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

TO LAY NEW ATLANTIC CABLE—It is understood that the German-Atlantic Cable Company, of Cologne, will issue four per cent debentures to the amount of 20,000,000 marks to defray the expense of laying a second cable from Germany to North America, the present cable already being inadequate for the increasing traffic.

THE PACIFIC CABLE—The contract for the laying of the direct Pacific cable to the Philippines, it is understood, was signed prior to the death of Mr. Mackay in London on July 20. This is expected to be finished by June of 1903, providing the Commercial Cable Company may have the use of the government surveys. If these are not available, the work will take as much longer as will be necessary for the company to make its own soundings. Mr. Mackay's death, it is expected, will not in any way hinder the carrying out of the original plans.

PENNSYLVANIA SYNDICATE MAKES LARGE TROLLEY DEAL.—The Camden Interstate Railway Company, of Huntington, W. Va., has sold to a Pennsylvania syndicate all of its electric lines in Huntington, Central City, Geredo and Kenova, W. Va.; Catlettsburg and Ashland, Ky., and Ironton, Ohio. It is understood that the deal will also embrace electric light plants in Ironton, Ashland and Huntington. The consideration is said to be $2,000,000. It is rumored that this syndicate has in view the purchase of electric railways in other Ohio cities, the ultimate aim being to have a continuous line between Cincinnati and Pittsburg.

POWER PLANT FOR JOLIET, ILL.—Announcement has been made of the plans of a large syndicate of Chicago and eastern capitalists to erect a water-power plant in Joliet, Ill. The Economy Light and Power Company has long leases on the water power at Jackson street, where there is a fall of fourteen feet, and has recently expended nearly $1,000,000 in a water-power plant that develops about 7,000 horse-power. Below Joliet, it is said, there are greater advantages. Private capitalists who are now in control of the water powers below Joliet are understood to have plans ready involving the expenditure of over $1,000,000. It is said that a dam will be constructed across the drainage channel a mile south of the city. The contemplated plan is to erect a plant to develop about 12,000 horse-power.

MARYLAND TELEPHONE CONSOLIDATION—The articles of consolidation of the Maryland Telephone Company, of Baltimore; the Western Maryland Telephone Company, of Carroll County, and the Boyd's Telephone Company, of Montgomery County have been filed for record in Baltimore. The name of the new company formed by the consolidation will be the Cumberland Valley Telephone Company, of Baltimore city. The company will have an authorized capital of $200,000, divided into 2,000 shares of $100 each. The officers of the new company are: President, John Hinkley; vice-president, William D. Barnard, St. Davids, Pa.; secretary, George W. Leonard, Baltimore; treasurer, Samuel R. Caldwell, Philadelphia. The directors are the officers and Thomas Foley Hiskey, Baltimore; Louis J. Burger, Baltimore; Howard E. Bokman, Baltimore; Ward R. Bliss, Chester, Pa.; Charles M. Clement, Sunbury, Pa., and Thomas J. O'Neill, Hanover, Pa. The shares of the new company will be distributed among the stockholders of the three old companies according to their holdings.

WORCESTER AND NORWICH TO BE CONNECTED ON A NEW SYSTEM—A sixty-mile system of street railways that will directly connect Worcester and Norwich, Ct., is being organized, and five trolley roads are to be combined into one big company. The five roads included are the Worcester & Webster, Webster & Dudley, Worcester & Connecticut Eastern, the People's Tramway, and Danielson & Norwich lines. The syndicate which is bringing about the deal is the Sanderson-Porter Company, of New York, which controls the Worcester & Connecticut Eastern, which is to be the name of the consolidated system. To complete this system, another road will be built, about twenty miles in length. After the deal is completed, passengers will be enabled to go by trolley from Norwich to New London, a distance of twelve miles more, making a continuous trolley service of over seventy-five miles. The line runs parallel with the former Norwich Division of the New York, New Haven & Hartford Railroad, now a portion of the Shore Line Division.

ELECTRIC LIGHTING

DANVILLE, KY.—The city council has appointed a committee to examine into the feasibility of establishing an electric light plant for this city.

WAUWATOSA, WIS.—At a recent meeting of the council a committee was appointed to investigate and report upon the question of building a municipal lighting plant.

HARRISBURG, PA.—A charter has been issued to the Home Electric Light, Heat and Power Company, of Steelton, with a capital of $1,000. The incorporators are Arthur P. Rupley, W. B. Boyd, Carlisle, and Stephen J. Boyd, Steelton.

NEW DECATUR, ALA.—The city council has granted a franchise to J. T. Crass and associates to construct an electric railway, light and power plant in the city. The ordinance gives six months in which to commence the construction and eighteen months to complete the system.

PONTIAC, MICH.—It is probable that Pontiac will have a municipal lighting plant. The street lighting contract will expire September 1, and a committee of aldermen has been appointed to get estimates on the cost of a plant large enough to light the whole city.

LEAD, S. DAK.—The Belt Electric Light and Power Company is building a new plant at Pluma, to take the place of the old concern, the change being necessitated by the increase in business. Poles are arriving for the line to Central City, and the latter place is expected to have electric lights inside of a month.

JACKSONVILLE, FLA.—The board of bond trustees held a special meeting to consider bids for the enlargement of the city electric light plant. At present the plant is being run to the full limit, but there are many applications on file which necessitate an increase. The bond trustees will use the funds obtained from the profits of the plant in making the improvements.

CRIPPLE CREEK, COL.—Two special elections have been held and franchises granted to the People's Electric Light Company and the Colorado Electric Power Company. Both companies agree to renew burned-out lamps without cost; to pay two per cent of the gross lighting receipts to the city treasury; to save the city about $6,000 a year on street lights, and to furnish free light to the city buildings.

ALBION, N. Y.—The Albion Electric Light and Power Company has come into possession of the Albion Gaslight Company's plant. Hereafter both gas and electricity will be furnished by the Albion Electric Light and Power Company. The company has increased its capital stock from $75,000 to $200,000, and intends to furnish gas and electricity in both Orleans and Niagara counties. The electric light and power plant in this village will also be enlarged, and other improvements will be made.

NEW YORK, N. Y.—A mortgage executed by the Queens Borough Gas and Electric Light Company to the Guaranty Trust Company, of New York, for $200,000, has been filed in the office of the clerk of Queens County. This company has absorbed the privileges, franchise and capital stock of the Queens Borough Electric Light and Power Company and of the Hempstead Electric Light Company. For the acquisition of further property and the extension of the plant $800,000 will be spent. A. H. Bronson is president of the new company, and Nelson R. Theall, secretary.

CARROLLTON, MO.—The Carrollton Water, Light and Railway Company has been organized by Carrollton and St. Louis parties, and has bought the Carrollton waterworks, the electric light plant and railway. All the companies have for some time been operated from one power-house, and the consolidation is made to increase the earning capacity of the property. The capital is $100,000, all paid. The officers and directors are: President, Herndon Ely; vice-president, T. L. West; secretary, P. L. Trotter; treasurer, J. T. Marshall; auditor, W. R. Painter; L. B. Ely and V. D. Ely, both of St. Louis, directors.

PERSONAL MENTION

MR. CHARLES E. BROWN, secretary of the Central Electric Company, Chicago, Ill., has been spending the week in New York city.

MR. JOSEPH C. MOULTON has associated himself with the Fort Wayne Electric Works at its New York office, 44 Broad street.

MR. JAMES ROWLAND BIBBINS has joined the Westinghouse companies' publishing department, having recently resigned the position of assistant electrical engineer of the Detroit United Railways.

MR. D. S. HULFISH has accepted the position of electrical engineer of the Baird Manufacturing Company of Chicago. Mr. Hulfish was formerly switchboard engineer of the Central Union Telephone Company.

MR. J. C. IRWIN, of the University of Pennsylvania, and who has had considerable practical experience in steam and electric railway signal work, has been made engineer of signals for the New York Central & Hudson River Railroad.

MR. C. W. STIGER is now manager of the reorganized Stromberg-Carlson Telephone Manufacturing Company. Prior to the acceptance of this position with this company, Mr. Stiger had been superintendent of construction for the company.

MR. RAY D. LILLIBRIDGE has removed his offices to the Broadway-Maiden Lane Building. Mr. Lillibridge is well known for his work in connection with the preparation of the literature of a number of large electrical manufacturing concerns.

MR. W. J. JONES has been appointed manager of the Denver office of the Stanley Electric Manufacturing Company, of Pittsfield, Mass. Mr. Jones, prior to this appointment, was associated with the management of the Gas and Electric Company, of Bergen County, N. J.

MR. LOUIS A. FERGUSON has been appointed second vice-president of the Chicago Edison Company and the Commonwealth Electric Company. Mr. Ferguson is president of the National Electric Light Association and of the Association of Edison Illuminating Companies.

THE RECENT NOMINATION for the Institution of Electrical Engineers of Great Britain is as follows: Mr. James Swinburne, president; Major P. Cardew and Messrs. S. Z. De Ferranti, John Garvey, Professor O. Lodge, vice-presidents, and Professor W. E. Ayreton, honorary treasurer.

MR. ROBERT M. TODD has been appointed general manager of the United Gas Improvement Company. Mr. Todd has been vice-president of the Cincinnati Traction Company, and has been identified with the Whitney-Widener-Elkins Syndicate for some years. He is a graduate of Johns Hopkins University, and is still a young man.

AUTOMOBILE NOTES

MIDSUMMER AUTOMOBILE SPEED CONTESTS—The Long Island Automobile Club will hold a midsummer speed contest at Brighton Beach race track, Long Island, Saturday, August 23, 1902. There will be ten events: A one-mile heat race for vehicles under 1,500 pounds; a five-mile race for steam vehicles, all weights; a five-mile race for electric vehicles, all weights; five miles for gasoline vehicles, 1,000 pounds and under; five miles for gasoline vehicles over 1,000 pounds and including 2,000 pounds; five miles for gasoline vehicles over 2,000 pounds; ten miles, free for all; twenty-five-mile lap race, open to all classes; obstacle race, open to all classes; and a pursuit race, open to all classes. The races will be held with the sanction and under the racing rules of the American Automobile Association. The course is a regulation one-mile track, eighty feet in width. The time of starting will be 2 P. M. If the number of entries warrants so doing, heats will be run off in the forenoon, beginning at eleven o'clock. The vehicles are to be in racing trim, no restriction being enforced as to the number of passengers or types. A flying start will be made in each race, and no prizes will be awarded in case of walk-overs. The entries close at 6 P. M., Saturday, August 16, with Mr. A. R. Pardington, Long Island Automobile Club, Brooklyn, N. Y.

STEEL ROAD FOR AUTOMOBILES—The steel roads committee of the Automobile Club of America is making rapid progress in the work, and through its energy, together with the liberality of the United States Steel Corporation and the hearty cooperation of the city authorities, a thorough demonstration will very soon be made in New York city of the merits of the steel highway system under various conditions of service. The chief difficulty was to get the special shape of steel rolled; none of the outside mills were willing to furnish it, or even to take an order for regular sizes requiring prompt delivery, but when Chairman Seligman, of the committee, met President Schwab, he found him in full sympathy with the movement, and ready not only to furnish the special forms and deliver them promptly, but to contribute the steel for a mile of road as a free gift. General Stone, the designer of the proposed road, has already conferred with the steel corporation's experts on the details of construction, and the material will be delivered in six weeks. President Cantor has shown a warm interest in the affair and by his direction Chief Engineer Olney is to recommend suitable locations for sections of the road. It is intended to place one in the heavy trucking region downtown, another in a street of general travel and a third on a suburban earth road. The track plates will be twelve inches wide and will be laid on special foundations of broken stone. An English engineer, who recently inspected the steel road at Valenci, in Spain, reports in the highest praise of it in every particular. This road has been in use for ten years.

TELEPHONE AND TELEGRAPH

NEWARK, N. J.—Formal application has been made by the New York & New Jersey Telephone Company for a franchise in Vallsburg.

LA FAYETTE, IND.—The South Raub Co-Operative Telephone Company has filed articles of incorporation with the Secretary of State. The company has a capital stock of $4,000.

SIOUX CITY, IOWA—The Sioux Valley Telephone Company, of Cherokee, has given notice to the Secretary of State of an intention to issue $25,000 of preferred stock, in addition to the same amount of common stock.

BOYD'S, MD.—The Boyd's Telephone Company has been merged with the new company to be known as the Cumberland Valley Telephone Company. The merger with the Maryland Telephone Company, of Baltimore, and the Westminster company, and the Western Maryland is now complete.

ALBANY, N. Y.—The Pennsylvania Telephone Company has purchased all of the lines and franchises of the Hudson River Telephone Company in that state. The local company is incorporated in three states—New York, New Jersey and Pennsylvania. It has secured several quite valuable franchises in Wayne and Pike counties, Pa., and has several exchanges in operation in the counties named.

LYONS, N. Y.—The Lyons Telephone Company and the Wayne County Telephone Company have been consolidated, with a capital of $50,000 and officers as follows: President, Charles A. Lux, of Clyde; vice-president, H. S. Wendell, of Philadelphia; secretary, C. N. Rooker, of Lyons. The directors are: H. S. Wendell, W. T. Bernard and Edward Davis, of Philadelphia; C. H. Towlerton and C. N. Rooker, of Lyons, and C. A. Lux and T. Robinson, of Clyde.

FREMONT, NEB.—The promoters of the new independent telephone system have commenced a canvass for subscribers, and in a short time the company will place an order for a large quantity of apparatus. The company will connect with the Farmers' Telephone Company, of Dodge County, and with the exchanges at Wahoo, Cedar Bluffs and Arlington, thus giving Fremont communication with all surrounding towns and a large extent of rural territory. Through Wahoo and Arlington connection will be had with many places in southeastern Nebraska and with Kansas City and St. Joseph.

PENN YAN, N. Y.—A new telephone company has been organized, to be known as the Crosby & Barrington Telephone Company, which will connect with the exchange of the Inter-Ocean company at Penn Yan. The company will be capitalized at $5,000, divided into shares of $50 each. The directors are: Howard Fullager, S. T. Thayer, Herbert Orenshire, A. P. Wortman, Isaac Crosby, T. W. Winduagh and Charles E. Guile. The officers are: President, Charles E. Guile; vice-president, Howard Fullager; secretary and treasurer, Herbert Orenshire. The work of construction will soon begin.

ELECTRICAL SECURITIES

A steady upward trend of prices and a broadening of speculation have been the gratifying conditions in the market throughout the past week. The conditions, indeed, almost assumed the proportions of a boom, and for this season of the year the daily transactions of last week are enough out of the ordinary to excite considerable comment. In view of the steady conditions which have been prevailing for some time and the present outlook, it would seem as if the bull movement would certainly run along for the immediate future, and especially as there are no indications in the financial horizon of any positive danger. There has been no important developments in the financial situation during the past week to explain in themselves the steady upward tendency of prices. The coal strike continues to drag along and there is no indication when it will end, although the recent action of the United Mine Workers' Convention would seem to foretell an early crisis. The financial circles were very agreeably surprised by the complete and most encouraging presentation of the position of the Steel Trust made by President Schwab in his affidavit in relation to the latest suit against the company, and the facts and figures as set out by Mr. Schwab when published brought about a decidedly enthusiastic feeling in favor of these stocks. Mr. Schwab values the properties of the corporation at $1,400,000,000, and expects heavy increase in the profits.

ELECTRICAL SECURITIES FOR WEEK ENDING JULY 19.

New York:	Closing.
Brooklyn R. T.	72⅛
Con. Gas	225½
Gen. Elec.	190*
Kings Co. Elec.	202
Man. El.	36½
Met. St. Ry.	150½
N. Y. & N. J. Tel. Co.	175
Westinghouse Mfg. Co.	215

*General Electric stock sold *ex* the stock dividend of 66 2-3 per cent which has been distributed to shareholders with the quotations running from 189¼, the opening price after the distribution, to 195½. The close was at 190. The last sale of General Electric prior to the distribution of the dividend was 315. Kings County Light and Power sold at 202 during the week. For the first time in many weeks Brooklyn Rapid Transit stock was pronouncedly active, and at advancing prices. It is announced that there is a hitch in the deal by which the Sprague Electric Company was to be acquired by the General Electric, the difficulty being due to a disagreement as to the value of the plants.

Boston:	Closing.
Am. Telep. & Tel.	165
Edison Elec.	277
Mass. Elec. pf.	97½
New England Tel.	141½
Western Telephone & Telegraph	105½

Philadelphia:	Closing.
Elec. Co. of America	6¼
Elec. Stor. Bat. c.	93
Elec. Stor. Bat. pf.	93
Philadelphia Elec.	5½
Union Traction	44⅞
United G. I. Co.	108

Chicago:	Closing.
Chicago Edison Light	177
Chicago Telep.	169
Metropolitan El. pf.	92
National Carbon	27
National Carbon pf.	100
Union Traction	17⅞
Union Traction pf.	51

LEGAL NOTES

THE PATENT FOR LUBRICATED BEARINGS FOR FAN MOTORS SUSTAINED—In the Circuit Court of the United States for the Eastern Division of the Eastern District of Missouri, the Emerson Electric Manufacturing Company, complainant, *vs.* Van Nort Brothers Company, defendant, the suit to restrain the infringement of the patents assigned to the Emerson company by Charles R. Mestin for an improvement in lubricated bearings designed especially for use in connection with electric ceiling fan motors is sustained. The court finds that the granting of a patent to Mestin is *prima facie* evidence of novelty and invention, and is unable to find anything either in the patented or unpatented structures relied upon by the defendant as anticipations to destroy the *prima facie* case made by the patent itself. The chief feature of the complainant's invention is the spiral groove or channel opening into the lower oil cup and extending up the bearing of the upper reservoir in such way as to permit the raising of oil on the principle of the Archimedean screw. This feature is the important element of each claim in the controversy, and cooperates with the other elements of each claim in such way as to make an effective machine. The court therefore concludes that each of the four claims in question involving the invention is valid. There is practically no dispute about infringement. The defendant's device involves the invention of each of the claims. A decree will therefore be entered for the complainant.

MOTION FOR PRELIMINARY INJUNCTION DENIED—In the case in equity in the Circuit Court of the United States, District of Massachusetts, the Westinghouse Electric and Manufacturing Company *vs.* the Stanley Electric Manufacturing Company, the motion for a preliminary injunction, which is based upon the decision of the Court of Appeals for the second circuit in the case of the Westinghouse Companies *vs* the Saranac Lake Electric Light Company, 113 Fed. Rep. 884, 108 Fed. Rep. 221, was denied. In that case the court held the Stanley patent No. 469,809, now in issue, to be valid and not anticipated by prior patents or by articles printed in various foreign publications prior to the date of Stanley's invention. In his specification Stanley described the method known as the "Stanley rule." The two claims in issue were broad and did not in terms include this rule. The court states in its opinion the defendant contended that the prior art showed anticipation of these claims because this so-called Stanley rule is no part of the invention claimed, and there is nothing in the claims requiring the rule to be considered as a part of the invention thereby covered. The court holds that "the so-called Stanley rule is therefore a part of the invention disclosed in claiming the patents. Indeed, it would seem to be the main part of that invention, and with the patent thus construed the citations from the prior suit show neither anticipation nor lack of invention. The whole argument of defendant on that branch of the case is so interwoven with the postulate that the Stanley rule is to be eliminated from the patent; that when the postulate is not granted the argument becomes wholly unpersuasive." The judge hearing this case does not agree with the complainant's counsel that the court in the former case found the Stanley invention to reside "in a certain length of primary winding," and their argument on this point seems to him plainly in conflict with the invention as defined by the court. On the question of validity, the Stanley patent is limited by the Stanley rule, while on the question of infringement there is no such limitation. In other words, a transformer may be outside the monopoly secured by the patent and still infringe the patent. After the Appellate Court in the other case had determined that the Stanley invention for the most part resided in the Stanley rule, and that the rule must be imported into the claims, and as the court said on the petition for rehearing, "as to infringing" it "did not deem it necessary to add anything to the opinion below," it is manifest that the court did not understand from the opinion of the court below that the Stanley rule was eliminated from the Saranac transformer. For these reasons the motion for a preliminary injunction must be denied.

ELECTRIC RAILWAYS

SAN BERNARDINO, CAL.—The San Bernardino Valley Traction Company has been granted a franchise for an electric line to be operated south from the extreme southern end of the company's present line in Colton to the city limits. It is expected that work will have been begun by November 1 of this year.

ALLENTOWN, PA.—The power-house of the Electric Light and Power Company has been totally destroyed by fire, which is believed to have been caused by the short-circuiting or crossing of the electric light wires underneath a portion of the floor. The loss is estimated to be about $100,000. The total amount of insurance carried by the company is $70,680. Of this amount $31,000 is on the machinery and $33,680 on the dynamos.

TACOMA, WASH.—Work has been begun on extensive improvements at the Tacoma Railway and Power Company's plant. The changes are such as will give more room for power equipment necessitated by the growing business of the company, and will afford new and more commodious quarters for the office force. With its additional equipment the plant will be capable of furnishing a tremendous amount of electrical energy for both lighting and power purposes.

INDUSTRIAL ITEMS

THE ELECTRIC SUPPLY COMPANY, Syracuse, N. Y., has just been awarded the contract for rewiring the Yates Hotel, of Syracuse.

THE SUNLIGHT LAVA MANUFACTURING COMPANY, Chattanooga, Tenn., in a neat booklet describes its acetylene burner apparatus. This will be sent to any one interested upon application.

S. G. THOMSON, 136 Liberty street, New York, manager of the New York office of the Adams-Bagnall Electric Company, of Cleveland, has recently been awarded a large contract for arc lamps for Washington, D. C.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, has just received a contract calling for an additional 1,080 lines for the Los Angeles (Cal.) exchange. This will bring the equipment up to 7,080 lines to start with.

THE SAFETY ELECTRIC SWITCH COMPANY, successor to the Hope Electric Appliance Company, Providence, R. I., is illustrating and describing its line of quick make and break switches and other apparatus for station and construction work. A complete price list accompanies each illustration, and the booklet will be sent on request by any one interested.

MCKINNEY & WATERBURY, Boston, manufacturers of artistic fixtures for electric lighting, carry one of the largest assortments of lamps and fixtures in New England. Their recent catalogue will be sent on application to the office of the company, 181 Franklin street, Boston. No concern in New England stands higher for the quality and originality of its work.

MR. CHARLES F. JOHNSON, Buffalo, N. Y., announces that he is ready to install railway equipment, cars, electric motors, generators, engines or locomotives. These may be had either second-hand or new. Mr. Johnson has a number of excellent pieces of machinery ready for immediate delivery, and enquiries pertaining to this matter will receive prompt attention from him.

ELECTRIC APPLIANCE COMPANY—In the distribution of a catalogue it is manifestly impossible to reach every one in the trade. The Electric Appliance Company, Chicago, will be glad to have the name and address of those interested in wattmeters who have failed to receive a copy of that company's new Gutmann alternating-current wattmeter catalogue. It will be mailed promptly upon application.

C. J. TOERRING COMPANY, Philadelphia, Pa., announces that owing to the great increase in its business it has been obliged to triple its manufacturing facilities, and its factory is now at Nineteenth street and Allegheny avenue. The company is also putting a new lamp on the market which it claims embodies all the best points of the old lamp with many additional features. This company's New York office is at 39 Cortlandt street.

TROLLEY TRIPS THROUGH SOUTHERN NEW ENGLAND—The publishers, White & Warner, of Hartford, Ct., are issuing this book in its fourth year larger and better than ever. The illustrations are numerous, and there are in addition nine maps—four of them used to show the trolley lines between Boston and New York, including nearly the whole of the states of Massachusetts, Rhode Island and Connecticut. The descriptive matter is of value, and many delightful and inexpensive itineraries may be made up from a perusal of its pages.

TO THE COURTESY OF THE WISCONSIN CENTRAL RAILROAD the considerable Chicago representation to the joint convention of the Independent Telephone Association of Wisconsin and the Northwestern Electrical Association at Waupaca, Wis. (the American Killarney), was very greatly indebted. For the convenience of the visitors a special dining car was run and certainly made far more appreciable the beautiful country through which the Wisconsin Central runs, covering so thoroughly many of the most popular Wisconsin fishing and holiday resorts.

THE STILWELL-BIERCE & SMITH-VAILE COMPANY is mailing its latest catalogue of Smith-Vaile pumping machinery. This catalogue is a splendid edition, describing and illustrating fully the line of machinery made by this company. Considerable general information and suggestions of an engineering nature are added, which can not fail to be of great value to any one interested in hydraulics and steam engineering. The book, complete, embraces 138 pages, is handsomely bound, and a comprehensive index adds considerably to the value of a very complete catalogue.

J. H. BUNNELL & COMPANY, 20 Park Place, New York city, reports a large demand for the new Ghegan automatic repeating transmitter. This apparatus is the invention of Mr. John J. Ghegan, the vice-president and secretary of the company. The government has recently ordered an installation of twelve of these instruments. They have also been installed upon the Baltimore & Ohio and the Erie Railroad lines, and on the Pennsylvania and Lehigh Valley, and the Postal Telegraph and American District Telegraph companies have also installed them on their lines.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has S. K. C. Bulletin No. 127, describing a fine line of switches, ready for distribution. Besides the well-known type of S. K. C. slide switches, carbon break switches, etc., many specialties are included, among which are combined oil-switch and circuit-breaker for great capacities at high voltage, and a line of knife switches, the blades of which are made up of units, providing a range in capacity from 50 to 3,000 amperes, single or double-throw, with or without fuses and with or without quick break. Requests for copies addressed to Ray D. Lillibridge, 170 Broadway, will receive prompt attention.

THE DE VEAU TELEPHONE MANUFACTURING COMPANY, 27 Rose street, New York, is the name of the company organized to continue the manufacture of the De Veau telephone apparatus. Mr. A. S. De Veau, president of this newly organized company, makes the following announcement: "I beg to announce that I have severed my business connections with Stanley & Patterson, Incorporated, New York, and from now on will devote myself exclusively to the manufacture of the De Veau telephone apparatus at my former address, 27 Rose street, New York, where we have a thoroughly equipped, up-to-date plant." The company also advises that on August 1 it will have a very complete telephone catalogue ready for distribution, and that this catalogue will be comprehensive in its descriptions and illustrations of long-distance and interior telephones, automatic switch telephones, flush telephones, switchboard apparatus, central energy telephones and switchboards and other special telephone apparatus.

WESTINGHOUSE, CHURCH, KERR & COMPANY announces the removal of its Pittsburg office from its former location on the first floor of the Westinghouse Building to more commodious quarters on the eighth floor of the same building. This change is the direct outcome of largely increased business in this district, and is accompanied by the acquirement of a commodious reception room devoted exclusively to the convenience and entertainment of visitors and patrons. The object of the management in making this change is to be able to accommodate more thoroughly and promptly the wishes and needs of its patrons, and to be prepared to give immediate attention to all classes of general engineering and construction work as applied to power and its uses in transportation and industry. The company will provide in all cases from its engineering force adequate personal supervision of work in hand, both during construction and subsequent thereto, and the increased facilities afforded by the new quarters will enable it to fulfill the most extensive contracts. The official address is, Westinghouse, Church, Kerr & Company, Westinghouse Building, Pittsburg, Pa.

THE NEW YORK EDISON COMPANY, New York city, is sending to its patrons and prospective customers the following circular notice, dated July 1: "We take pleasure in informing you that on and after September the first, the rates prices for the incandescent service of this company will be reduced from the present maximum of twenty cents to a maximum of fifteen cents a kilowatt hour. The full schedule, after that time will be, for the first two hours of average daily use of the connected installation fifteen cents a kilowatt-hour; for the third and fourth hours, ten cents; for the fifth and sixth hours, seven and one-half cents and for all over six hours, five cents a kilowatt-hour. This immediate notice is sent to those interested in electrical work that they may be first advised of the reduction; a corresponding and timely announcement will be made to our customers and to the general public. To the greater number of the users of electric light, perhaps more especially the residential users, this change will represent a reduction of nearly twenty-five per cent and the result should be to greatly broaden the field of electrical installation, as well as of electrical supply."